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VOLUME 8, No. 9 **SEPTEMBER 1956**
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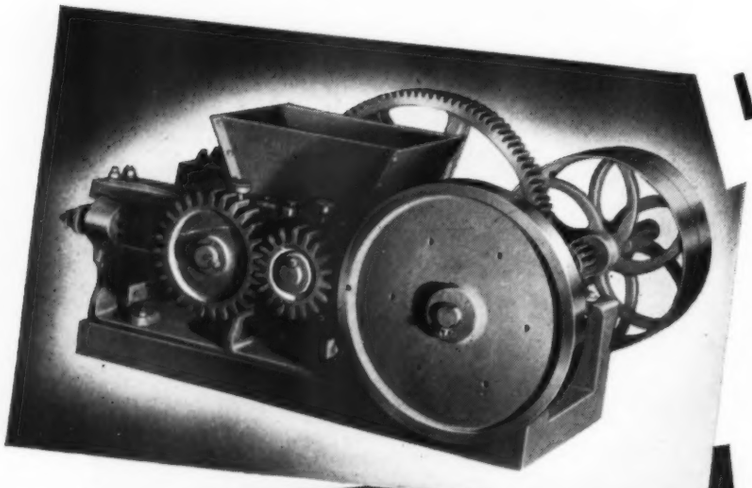

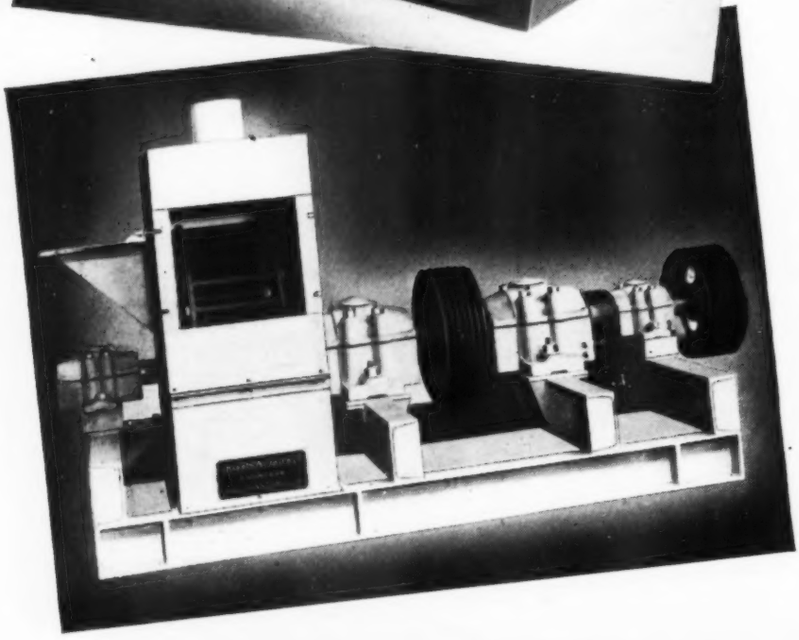

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WORLD CROPS

Vol. 8, No. 9

CONTENTS

SEPTEMBER 1956

EDITORIAL COMMENT:
Within My Orchard; Vegetable Research; Shelter for Increased Output; Curried Wheat, Anybody?; Sea Harvest; Scientific Superiority Not Enough; Copper and Tobacco; Troublesome Plants; Threat to Britain's Farming; Dutch Reclamation Scheme 331

Developments in Orchard Equipment: A Summary of Progress in Britain—*B. W. J. Wulff*, B.SC., A.R.C.S., D.I.C. 335

Solar Energy—I: The Water Problem and its Relation to Solar Energy—*A. V. Brancker*, PH.D. 339

The Role of Fertilisers in Rice Production in Tropical and Semi-Temperate Climates—*L. J. Carpentier* 345

Work of the Colonial Development Corporation—*H. Nutcombe Hume*, C.B.E. 350

Some Difficulties in Field Experimentation with Cocoa on the Gold Coast—*T. N. Hoblyn* 355

Scientists from 42 Countries at Plant Protection Conference 361

Machinery, Co-operatives and Land Limitation in Yugoslavia 368

New Publications 373

Machinery and Equipment 375

World Crop Reports 379

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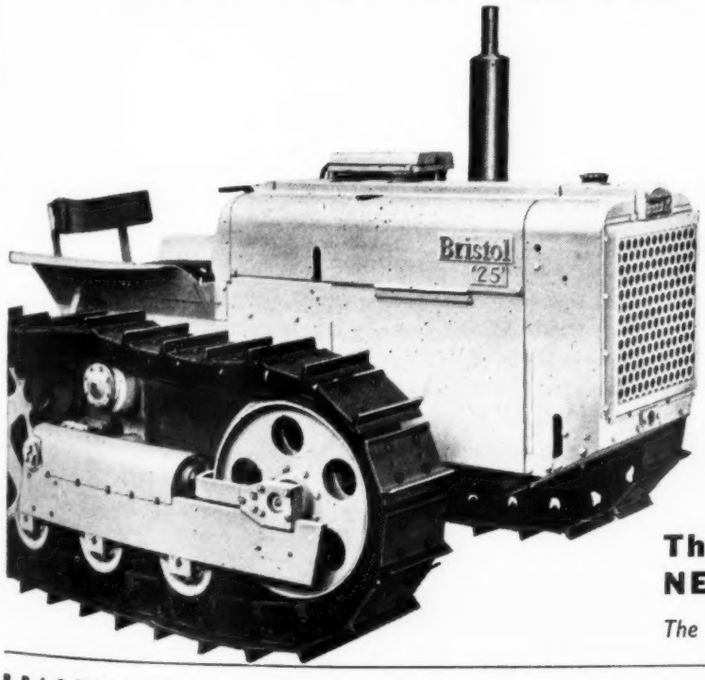

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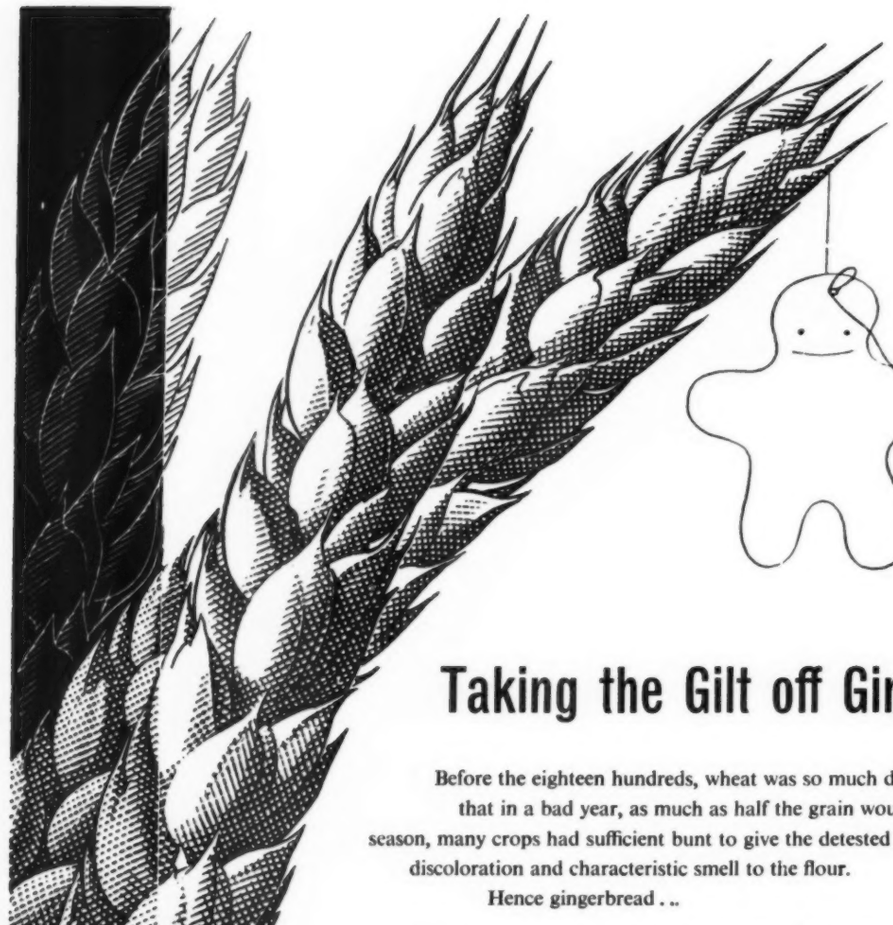

Taking the Gilt off Gingerbread

Before the eighteen hundreds, wheat was so much diseased by bunt that in a bad year, as much as half the grain would be lost. Even in a good season, many crops had sufficient bunt to give the detested violet discoloration and characteristic smell to the flour.

Hence gingerbread . ..

Highly flavoured with ginger, these treacle cakes in fanciful shapes were gilded to make them still more attractive. But take the gilt and the ginger from the gingerbread and we find it was just a cunning way of disposing of rather unpalatable flour! No one could detect the smell and colour of bunt under such a heavy disguise. Then work was begun to prevent the disease.

Treating cereal seed with organo-mercurial seed dressing against bunt is now standard practice. And the pioneer work by Plant Protection Ltd on a combined organo-mercurial/gamma BHC dressing for protection against both bunt *and* wireworm has become another standard farming practice.

There is unending research by Plant Protection Ltd and its parent company Imperial Chemical Industries Ltd, working in collaboration with universities, government research organisations and other official bodies throughout the world. Their aim is to find new chemical treatments to protect crops from weeds, pests and diseases. The benefits of this research are made available through their Agents to farmers and growers at home and overseas.

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Editorial Comment

Within my orchard

OUR feature article this month outlines some of the advances that have been made in the design and operation of orchard and packing-house equipment. The author, an undoubted expert in his field, compares the most recent developments with the progress in automation now taking place in other industries, and causes us to pause momentarily and reflect ' What will be the outcome? '.

If automation in the orchard tended to progress apace the city engineer (from the control panel of his automatic brain perhaps) might ask of the orchardist ' How do you fill in your spare time? ', only to receive the Shakespearean retort ' Sleeping within my orchard, my custom always of the afternoon '. Mr. Wulff, however, is certain that no such conversation will take place, at least in Britain.

The art of the orchardist is largely an *affaire intime*. Cultivating implements and spraying machinery account for the great bulk of orchard equipment but there are, too, the hand tools such as pruning saws and secateurs. Although several machines have been developed in North America and elsewhere to overcome some of the tedium the greater number of orchardists still prefer to use manually operated tools to modify the natural habit of the fruit tree, so improving its commercial value as a cropping unit by securing more regular and prolific crops of good-quality fruit.

Vegetable research

THE necessity for increasing food production in Britain during the 1939–45 war and the appreciation that this need would continue in future led to the establishment of the National Vegetable Research Station at Wellesbourne, Warwickshire, England, and its sub-station at Paglesham, Essex, in September 1949.

The station and its sub-station are controlled by a governing body registered as the British Society for the Promotion of Vegetable Research. The properties at Wellesbourne and Paglesham are leased to the Society by the Minister of Agriculture, Fisheries and Food and the Agricultural Research Council provides the Society with funds for the development and running of the station.

The property at Wellesbourne has much to commend it as a site for the N.V.R.S. The soil and climate are near average for vegetable cultivation and are similar to those of the nearby Vale of Evesham, where vegetable production is an important industry. The soil is a sandy loam without excessive variation and the land is flat; these features are desirable for vegetable production and are essential for field research work. Market gardening has not been practised on it and is not carried out to any great extent in the neighbourhood. It follows, therefore, that the experimental crops are unlikely to be contaminated with pests, diseases and pollen of vegetable crops which would upset research work. The area of 280 acres is large enough to permit the isolation necessary for certain investigations and to allow a farm unit to be run with the object of building up the soil fertility to the high level required by the vegetable research unit. Since Wellesbourne is situated near the centre of England, it is not really remote from any other part of the country and is easily reached by rail and road.

The sub-station at Paglesham consists of 150 acres of fertile loam. The climate and other conditions in Essex account for its being the main vegetable-seed-producing area in England. The main purpose of this sub-station, therefore, is for the multiplication of stocks of seed of vegetables bred by the N.V.R.S. and for the investigation of problems peculiar to this line of work.

Seven research sections have been set up to deal with the breeding of improved varieties, the control of pests, diseases and weeds, the improvement and maintenance of soil fertility, the study of irrigation, and with the planning of experiments and analysis of the results. There are 34 scientists and 31 assistants on the research staff and hence there is a considerable amount of research in progress in the laboratories and the fields, although some of it is still in its early stages.

The first open day was held recently and the results of seven years' work were in evidence. The Society is to be commended for its labour and we wish it continued success.

Shelter for increased output

ONE of the topics discussed at the congress of the International Union of Forest Research Organisations, which met at Oxford, England, recently, was the value of tree shelter-belts in increasing the growth and production of agricultural crops. Prof. H. G. Champion, of the Imperial Forestry Institute, Oxford, spoke of the use of model shelter belts in wind tunnels, such as are used in testing aircraft, to gauge the effect of belts of various widths, shapes and heights on wind velocity.

It was stated in a research paper from the Netherlands that shelter belts increased the yield of certain crops and actually caused more rapid ripening of strawberries. In south-east Russia the yield of various agricultural crops was said to be doubled or even trebled in dry weather as the result of shelter provided by tree belts systematically sited. One delegate from

Israel said that an increase in yield of up to 11% was obtained where potatoes were planted within a prescribed distance of a shelter belt.

At another session of the congress the fluctuations in population of forest insects which are harmful to tree crops were discussed. These pests are subject to attacks by birds, other insects, animals and diseases, as well as inclemencies of weather. One group under the chairmanship of Prof. G. C. Varley discussed problems of reducing these harmful insects, although it was pointed out that more research is still required, especially to obtain a better understanding of the factors of natural control. Virus diseases of insects that damage trees were also discussed, but the view was expressed that only by additional research could it be determined whether or not they could be used as an effective control measure.

Other delegates taking part in a discussion on forestry practice recommended the adoption of an international system for recording the characteristics of growing trees so that the results of experiments in different countries can be more easily compared.

Curried wheat, anybody?

THE assumption that all Japanese and Chinese are born with a special craving for rice and that a Neapolitan would rather starve than exchange his spaghetti for milk and eggs has just had a rude jolt. The U.S. Department of Agriculture, having made a survey of eating habits around the world, finds that they are changing rapidly. Its findings have led it to some remarkable conclusions.

The Orient's fondness for rice, the Department is convinced, is not due to any peculiar formation of the Oriental's taste buds. It is that rice has always been cheaper than either wheat or meat. The proof, the Department finds, is found in what happened during the postwar years when rice was scarce, and therefore expensive. The Singhalese and Japanese turned to eating wheaten bread and the habit has remained. Now that rice is relatively cheap again, people have gone back to the rice bowl, but there is likely to be a slice or two of bread beside it.

In the same way people in many heavily populated lands learned to like dehydrated milk in the postwar years when it was offered to them free. Now they like it and buy it freely.

It is not only Orientals who choose their diets according to their pocketbooks. In the U.S.A. for instance, rising incomes have brought a 20% increase in the *per caput* consumption of meat and milk products since the war.

These findings suggest that U.S. farmers may, after all, find new markets for their products. Who knows but that the Chinese can be taught to enjoy American chop-suey ?

Sea harvest

RECENT reports from several sources have mentioned tests being undertaken with a mechanical reaper for harvesting under-water crops of seaweed. If successful it is expected both to reduce the cost of gathering seaweed crops and to extend the range of operation in this field. It has been suggested that a mechanical reaper might extend economic harvesting up to a depth of 35 ft. This would open up countless areas of shoreline.

The submarine reaper has been developed by the Massachusetts, U.S.A., firm, Seaplant Chemical Corpn., with the help of a research team from the Battelle Memorial Institute, Columbus, Ohio. The need to speed up the methods of harvesting has been generated by the growing demand for seaweed extractives, and the desire for greater standardisation. Extracts of seaweed have become an important component of many industrial products. Their principal use is in the food and drug business, where they perform the functions of thickening, gelling and stabilising agents.

Until now, says the *Financial Times*, London, seaweed has been harvested by raking the crop from the sea bed in dories. This hand process has been slow and costly. Also, operations have been limited to areas where the bottom is only a few feet from the surface.

Scientific superiority not enough

A COMPLAINT often voiced in agricultural and industrial circles is that many technical advisers do not have a sufficiently practical approach to their subject. Deliberately or unintentionally, they attempt to cloak their practical and business inferiority with their scientific superiority.

These views have been confirmed by an expert mission of British farmers which, sponsored by the Nuffield Foundation, recently investigated farming advisory services in North America. Their report recommends that, as in America, district officers of the British National Agricultural Advisory Service, should be trained in ' farmer-approach ', should have a realistic business attitude to farming, and should have a practical background. Scientific superiority, they say, is not enough.

In their view, the National Agricultural Advisory Service, set up in 1946 to assist farmers to increase their efficiency should be freed from its administrative tasks and removed from direct Government control.

It is estimated that at the moment the advisory services reach one-third of ' better-off ' farmers and only one-sixth of the ' worse-off ', who need it more. The team feel that the NAAS should be linked with agri-

cultural colleges and decentralised. This would enhance the status of district officers who visit farms.

In America greater stress is laid on the profitability of better farming and an important feature of the work is ' programme planning ' in which advisers and local farmers co-operate. The results of research are more easily available to American farmers and are more quickly applied. English farming would certainly benefit, it seems, by having a more practical attitude to research.

Copper and tobacco

AN unusually interesting research paper on the importance of copper as a nutrient for tobacco was published recently. It notes that from 1946–47 onwards a breakdown condition of leaf was intermittently but increasingly experienced at a sandy-soiled farm. Affected leaves were found to be low in sugars after flue-curing. In the field the disorder was characterised by greyish-brown and ' greasy-looking ' spots between the veins, usually showing up first towards the leaf tip, but often spreading to all parts of the leaf during plant growth.

The earlier investigations might easily have been misinterpreted. Plot trials using different rates of nitrogen and different kinds of nitrogen fertilisers indicated that the trouble was associated with nitrogen supply. It had also been particularly severe on a field rich in nitrogen from former legume cropping. A strong case against the use of nitrogen for this crop could easily have been made out. The disorder was checked, for example, when a compound fertiliser, containing 2% of nitrogen, was used, but it appeared in the crop progressively as the nitrogen content of fertiliser reached 3% or more.

Here the importance of leaf analysis as a guide to plant disorders was evidenced. Although it was shown that affected leaves were rich in protein and nitrogen, it was also shown that they were abnormally low in copper content. During four successive seasons various applications of copper sulphate eliminated this type of leaf breakdown; the effective rate fell between 20 and 50 lb. per acre. Also a generally improved quality of leaf was secured, the effect of copper being to keep down the protein nitrogen and raise the sugar in tobacco-plant foliage. How far this effect could be generally obtained in tobacco growing seems a matter for wider investigation. The New Zealand research workers point out that symptoms of copper deficiency do not seem to have been reported for field-grown tobacco crops.

This New Zealand evidence for copper's importance rests upon observations at two farms. The research might easily have stopped short when it looked as if the trouble was due to nitrogen, but the low rate of nitrogen supply seemingly needed to avoid the leaf disorder was also too low for securing profitable yields. This account of a fairly long and detailed paper is necessarily brief and we suggest that the original might be most fruitfully studied in full by tobacco growers outside New Zealand. The full text was published in *New Zealand Journal of Science and Technology*, 1956, [A] **37**, 584.

Troublesome plants

THERE are, fortunately, few diseases in Northern Ireland to-day which will, within a matter of weeks, cause the death of 30 cattle in a herd of 42; yet such a loss was suffered by one Northern Ireland farmer not long ago. Last spring another farmer had 16 deaths in his herd. These are but two examples of what can happen when cattle obtain access to ragwort or ' benweed '.

The law requires farmers and gardeners to destroy any ragwort, thistles, docks or ox-eye daisies growing on their land. No weed ' earns its keep ' on the farm; benweed is poisonous; garlic, buttercup, ox-eye daisy and others may taint milk; charlock, shepherd's purse and other weeds of that family may harbour the turnip fly and can be instrumental in the spread of club-root disease; all weeds use plant food and space that could more profitably be utilised by crops or grass.

The destruction of weeds as and when they appear is an essential part of any programme designed to keep them in check. To allow them to grow to the seed-bearing stage can only add to the problem in the following year. But there are many other steps the good farmer will take in an effective programme of weed control. Some of these are considered in the June issue of the Northern Ireland Ministry of Agriculture's Monthly Report, which contains an article on the menace of weeds, with particular reference to ragwort. This article, which examines the way in which weed seeds are spread, deals mainly with cultural methods of control—crop rotation, liming, drainage. Chemical methods of control will be discussed in the next issue of the Report.

Threat to Britain's farming

A FORECAST that disaster may be facing 65% of Britain's farmers has been made by Mr. Lionel Harper, president of the Agricultural Engineers Association. Speaking at the opening of the Royal Show of the Royal Agricultural Society of England, he urged Whitehall to get in behind and push and lend their weight to the efforts of the agricultural machinery industry of Britain.

If small cash loans were denied to Britain's small farmers and a 50% cash deposit was demanded for vitally needed farm machinery; if at the same time there was imposed upon them the burden of the £12,000,000 additional costs for which they were not

reimbursed in the price review; add to this the losses they were now enduring on fat cattle, along with staggering imports of chilled beef from the Argentine; while men continued to leave the farms at the rate of 24,000 a year and were not replaced with mansaving machinery; Britain could expect nothing less than disaster on its small farms which constitute more than 65% of the farms of Britain, said Mr. Harper.

A 50% cash deposit on luxury goods may be justified but not on a tractor, a combine, or implements that increase productivity. These things help farmers to make their farms pay, to compete on a more equal footing, and by reducing the amount of imported food to do their share in putting right Britain's balance of trade. The 50% cash deposit on farm machinery is a thoroughly bad measure and should be rescinded.

The agricultural machinery industry regards the home market as an essential basis for its export trade. Unless it has this basis of a firm home market, it will be left behind by Russia in the new trade war for East and Middle East markets, in which money formerly spent on armies is now being spent on ploughshares. It is known that Russia, besides making gifts of agricultural machinery to various countries, is now setting up tractor factories in Indonesia, Egypt and the Yemen. Similarly the trade battle with Germany for the export trade is becoming increasingly fierce.

Britain's most stable markets, such as Australia, are finding it difficult to buy from Britain because of its policy of purchasing too much agricultural produce from a people who purchase no agricultural machinery from Britain, namely, the Argentine, to which Germany sent £7,000,000 worth of agricultural machinery in 1955, but whose markets seem closed to Britain.

The Minister of Agriculture, the Board of Trade, and the Chancellor of the Exchequer should relax their grip on cash loans to small farmers and eliminate the 50% hire-purchase deposit on farm machinery. When considering the Anglo-Argentine trade and payments agreement, the Government should make certain that a fair deal is given to the farmers of Britain, to its best customer, Australia, and to the agricultural implement industry. Only then will the farmers and the industry, which together form the largest contributors to the country's export trade and the balance of payments, be able to forge ahead with confidence and vigour.

Dutch reclamation scheme

AN interesting account comes from Holland of a scheme, already in operation, to reclaim land on a big scale from what is known as the Zuider Sea.

The size of the scheme can be judged from the fact that, when completed, the reclaimed land will constitute a new province. It will increase the size of Holland by 7% and the country's arable land by 10%. Such schemes of reclamation are, of course, not new. Two large inlets of the Zuider Sea have already been reclaimed during the last 25 years. But the scheme now in progress is a truly colossal project and is being carried out on a long-term policy that will cover many years.

The Zuider Sea was originally a vast inlet of the North Sea running far into the interior of Holland. The first step was to seal off the southern area of the Zuider Sea and this was done many years ago by means of a great dike or dam. When completed, this dam made the enclosed section of the Zuider Sea into an immense inland lake, to which the Dutch gave a new name. It is now called the Yssel Lake. The next step was to reclaim an area of some 50,000 acres near the north-western corner of the lake and at the southern end of the great dam. This work was done as far back as 1930, and the area is known as the Wieringermeer Polder. The word polder is given by the Dutch to any area of land reclaimed from water, especially the sea.

The next step was accomplished between 1937 and 1942, when another large inlet on the north-eastern side of the Yssel Lake, consisting of 119,000 acres, was reclaimed. This is now called Noordoost Polder.

The scheme at present in progress is still more ambitious. It proposes eventually to reclaim some 377,000 acres in all and thus to add a twelfth province to Holland. A whole fleet of dredgers, tugs and hopper barges is at work in an area south of Noordoost Polder, called East Flevoland, for the biggest reclamation scheme yet attempted. A dam 56 miles long and 70 yd. wide is nearly finished. It encloses 133,000 acres of water.

After Eastern Flevoland two more polders will be reclaimed, Southern Flevoland and Markerwaard, with a combined area of 244,000 acres. These three polders will constitute the new province. Work on East Flevoland began in 1950. In the middle of this enclosed portion of the sea, on an artificial island, the Dutch began to build what is to be the capital of the new province. Already there are barracks and houses for the workers, shops, offices, a cinema and a hospital. This new town and future capital is called Lelystad, after the man who has done most to reclaim new Holland from the sea. It is planned for Lelystad to have a population of 30,000, and a second town of 5,000 inhabitants and ten villages are also planned. A canal, 1,300 ft. wide, will link Lelystad with Yssel Lake and with Amsterdam.

After the present dredging operations are completed, pumping will commence. The three great pumping installations are able to draw off a million gallons every minute, but it will be approximately nine months before the whole polder is drained. The Dutch will be waiting for dry land to appear next spring, at any rate in the shallower parts. These will be at once prepared for agriculture.

DEVELOPMENTS IN ORCHARD EQUIPMENT

A SUMMARY OF PROGRESS IN BRITAIN

B. W. J. WULFF, B.SC., A.R.C.S., D.I.C.

(*The Mi-dox Company, Smarden, Kent, England*)

Since the second world war many advances have taken place in the manufacture and design of machinery used in the orchard and packing house. In the U.S.A. and Canada particularly stress has been on the development of more or less automatic equipment, and pneumatic pruners, for instance, are used commonly in those countries, but Britain has been slower to substitute mechanical methods for the older hand methods. Nevertheless, there have been some interesting developments in Britain, more perhaps with spray and ancillary equipment.

AUTOMATION, though a comparatively new word, has crept upon us apace over the last 20 years and its progress in the growing and handling of fruit has been no less startling than in other fields. Looking back only to the years before the last war, orchard equipment was centred largely around the horse. There can be little doubt that the replacement of the horse by tractors has, as in other farming, been the biggest single development and has opened up enormous new possibilities for the horticultural engineer.

It is not proposed to discuss tractor development in the short space of this article, although several models have been designed specifically for orchard use, nor to dwell upon the implements used in general farming practice, which have equally proved a boon in orchard cultivation, but to concentrate on the machinery specific to orchard practice.

In the main, the specialised operations involved are pruning, cultivation or mowing (depending on whether the orchard is arable or grass), spraying, harvesting and handling of the crop.

Pruning equipment

In Britain pruning is still mainly carried out with hand-operated knives or secateurs, but in many countries, notably America, pneumatic pruners are finding a place among the commonplace orchard tools. On this side of the Atlantic we are slower to substitute mechanical methods for the older hand methods. This is, no doubt, in many ways an advantage, since it is all too easy to indulge in mechanisation for its own sake only to find that large sums have been invested in equipment requiring considerable maintenance without any appreciable saving in labour or improvement in the quality of the work. Pruning will always be a skilled operation involving the selection of the branch to be cut. Thereafter the tool used must be brought to the branch and only in the actual cutting can any saving be involved. But, for large trees growing strongly, there is probably much to be said for mechanical pruners, particularly since three or four can be worked off one tractor-mounted compressor, keeping the capital investment per operator within reasonable limits.

Another pruning aid virtually unknown in Britain is the hydraulic platform, designed to take the place of a ladder. Although this, of course, also has its uses at picking time, one tractor and driver will be tied up together with an expensive piece of equipment for a maximum of two men working from the platform. It is improbable, therefore, that its use will show any saving, except in countries where wage rates are extremely high. Furthermore, since 90% of the fruit planted in

[Courtesy N.I.A.E., Silsoe, Beds]

Fig. 1. R.S.M. mist sprayer (A/S R. Sigvardt, Orehoved, Denmark). This machine secures even distribution by using varying-sized outlet spouts and nozzles

England since the war is bush-type trees, long ladders are likely to become scarcer in our orchards and the use for this type of equipment will diminish rapidly.

Cultivation

Passing to cultivation, a tool appeared on the market a few years ago which does not seem to have been adopted so widely as its ingenuity deserves. This is the so-called ' Thinking Cultivator ', which is steered clear of the trees by feeler arms striking the trunks. Even though the action of these feelers is comparatively gentle, it is not suitable for very young trees and most orchards in England are grassed down very early. In countries where cultivated orchards are more commonly encountered, however, this tool merits wider use.

For grassed orchards the introduction of rotary grass cutters in place of gang mowers has brought about an enormous saving, not only in initial cost of equipment, but also in maintenance costs. From an aesthetic point of view there can be no doubt that a gang-mown orchard looks better, but from a functional point of view the rotary cutter does all that is required and has the enormous advantage, in addition to cost, that prunings, other than branches, can be left on the ground and are cut up and mulched in the course of the season, whereas a small twig is sufficient to jam a gang mower.

Spray equipment

In no single type of orchard equipment have so many changes been made in so short a time as in sprayers. About 20 years ago all spraying was carried out by hand lances worked either from headland pumps or, in the better equipped orchards, from underground mains. In both cases long lengths of hose were necessary and much effort was needlessly expended on dragging these over the ground and a large wastage of chemicals resulted from the considerable volume of wash necessary to fill the hoses and underground mains. Since most of the chemicals in common use at the time were cheap, this was, however, unimportant, but to overcome the first difficulty the pull-through sprayer gradually replaced the headland sprayer, enabling the machine to be taken to within a few yards of each tree. Even so, a team of three men could spray little more than 5 acres a day.

The next step, therefore, was to replace the lance men by a series of nozzles, both fixed and oscillating arrangements being tried. The main disadvantage of this arrangement is that, since carry of droplets to the top of the tree depends entirely on their own kinetic energy, high pressures are necessary and a fair amount of mechanical damage to the lower branches cannot be avoided. Even so, distribution of wash in the tree is inevitably very uneven, the lower branches being covered to run-off point and beyond, and only a spatter of spray reaches the tops of the trees.

So as to give the droplets a greater range of travel a fan was added, giving the autoblast type of sprayer.

This was, however, still a machine primarily designed for conventional high-volume spraying and, although the advantages of cutting the several thousand gallons of water sprayed on to each acre of orchard in the course of a season had long been appreciated, the attempts at atomisation had all failed by ignoring the question of reach of the droplets from the atomiser against even a gentle breeze. With the advent of the autoblast a tool was put into the grower's hand which solved this problem and it was not long before volumes of wash per acre were being cut. From the start it was appreciated that the aim must be to leave the same amount of chemical on the tree as had by past experience been found necessary to deal with the pest under consideration. Assessment of this quantity is not easy, since at low volume the trees are able to hold a higher proportion of the liquid applied and run-off is very considerably reduced.

It has been found that the equivalent of 200 gal. of high-volume wash per acre is as much as is necessary when low-volume methods of application are used, *i.e.* at 50 gal. per acre, four times the normal concentration of chemical should be used, at 20 gal. per acre 10 times normal concentration of chemical should be used. This is certainly the case with protective sprays if they are to be as lasting when applied at low as at high volume. In cases where an immediate kill is required and residual is unimportant greater economies are probably possible.

The autoblast has two main shortcomings for low-volume work—it gives a large droplet and, as there is free outlet for the air from the fan, large volumes of air are necessary to give the required distance of travel of the droplets or reach, with consequently high power requirements. For low volumes small droplets are essential, since it is no longer the aim for the wash to run over the leaves, but to cover them with a pattern of distinct globules, and the smaller these are the closer they will be and, therefore, the better the cover will be. Further, the small volume must be distributed

Fig. 2. Inclined belt apple grader (S. de Vries, Leeuwarden, Holland)

evenly throughout the trees and if the centres of the tops are to be covered the long reach must be maintained. Unless, however, this can be done without excessive power consumption, the economy of low volume is impaired and its application limited.

The chemical economy and savings in water carting with consequent speeding up of the job naturally prompted designers to perfect machinery for low-volume spraying and led to the present-day directed air-blast sprayers or mist sprayers. To overcome the objections to the auto-blast, all of these concentrate the air blast into one or more shaped outlets, thereby obtaining high air velocity with very much lower air volumes. This high-velocity air will enable the reach to be maintained and by placing the nozzles in the air outlet greater break-up of the droplets is achieved, particularly if the nozzles are directed against the air flow, when a high relative velocity between the partially atomised wash from the nozzles and the air stream is obtained. To achieve even distribution of the comparatively small amount of spray-laden air, some machines use a single movable air outlet controlled by an operator and the cover obtained is entirely dependent upon his skill and vigilance. Furthermore, two men are required, one to drive and one to operate the air spout. Other machines, such as the R.S.M. mist sprayer (Fig. 1) secure even distribution without introducing the human element by using varying sized outlet spouts and nozzles, the largest uppermost, whereby more of the spray is directed into the tops of the trees, which are furthest from the machine, than toward the relatively close lower parts of the tree. The result is a uniform spray cloud which can be shaped to fit the trees to be sprayed by using as many of the four outlets as may be necessary.

Recently several machines and modifications of existing sprayers have been devised to enable spraying to be carried out at 3 to 5 gal. per acre. It is, however, yet to be proved that the results are better or the economy greater than at, say, 20 gal. per acre.

Packaging

In view of the competitive state of the fruit market today, it is more than ever important to grow high-quality, clean fruit. To this end spraying is probably the single operation of the greatest importance, since this will make or mar the appearance of the fruit and its market value. Few growers, however, sell their crop at the foot of the ladder and an operation of vital importance to the economic result of the orchardist's labours is the presentation of his produce on the market. A poor-quality fruit, well graded and packed, will often fetch a higher price than top-quality produce poorly packed. So specialised is fruit handling and packing becoming that an increasing number of growers are joining co-operative packing organisations who can concentrate on the techniques of fruit handling as opposed to fruit growing. However, whether they handle the marketing themselves or through a co-operative organisation, most growers aim to keep some control over this final stage of their produce, which can hold the key to profit or loss. It is, therefore, not out of place to make brief mention in this article of the equipment involved.

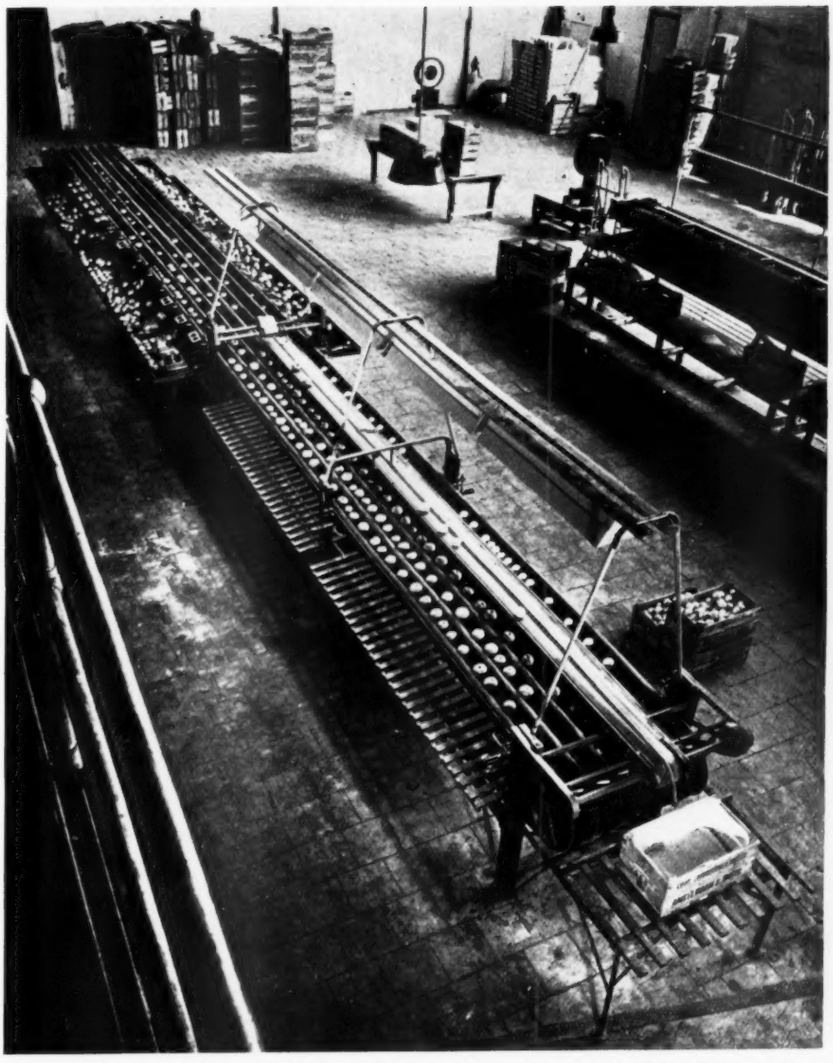

Fig. 3. Diverging belt apple and pear grader on the premises of S. de Vries, Leeuwarden, Holland

Orchard fruit is almost everywhere picked in boxes or trays and for bulk handling roller conveyors and the pallet system, using fork-lift trucks, are ideally suited. Since many cold stores were built before the days of the pallet system, several miniature lifting arrangements have been designed which will pass through the narrow doors often encountered.

Grading

Grading of the fruit consists generally of two operations—sorting for quality and sizing. Very occasionally

colour grading is also practised. Although various electronic methods of fruit sorting have been proposed, no commercially successful machine appears to be on the market at present and reliance must be placed on the human eye and human hand. Inspection belts which rotate the fruit, allowing 100% inspection without handling, are often used, but generally these give rise to scoring of the fruit; since in addition such equipment is generally used in conjunction with a feed chute, into which the apples are tipped, a further source of damage is introduced. The best and cheapest method, therefore, seems to be hand feeding to the grader, simultaneously sorting into quality grades. The sizing operation may be carried out in many ways, but the inclined belt with sorbo rubber sizing blocks and the diverging belt are among those which in practice have consistently shown the greatest accuracy of sizing combined with freedom from scoring or bruising.

Fig. 2 shows an inclined belt apple grader for separate sizing of three qualities, culls being led away at the back of the machine. This type of grader may also be fitted with a brush along the back of the sizing blocks which serves the double function of polishing the fruit and supporting it with its axis at right angles to the sizing blocks, giving greater consistency of grading. This brush is of particular value when handling awkwardly-shaped fruit such as Bramley's Seedlings and enables also pears to be handled satisfactorily.

Fig. 3 shows a diverging belt grader. The six belts allow handling of three qualities, feeding from both sides, culls being eliminated on the overhead reverse-direction belt. On this particular grader the cloth belts travel over strips which diverge in a series of parallel steps, thus overcoming the usual fault of this type of machine, that the largest fruit in any grade accumulates at the forward end of the receiving tray.

On most graders arrangements can be made for automatic filling of boxes, but a majority of this equipment gives rise to more bruising than is normally allowable, and removal of the fruit by hand into boxes for transport to packing tables is usually practised. Packing direct from the trays with all but a very uniform sample of fruit gives an uneven flow of work, disturbing piecework rates and reducing output of the packhouse.

From this brief survey it is remarkable to note that automatic methods and new equipment have made as great strides in the orchard as in the packhouse, although the latter is acknowledged to have developed on modern factory lines. A fully automatic packhouse, although not yet perfected, can well be imagined, but in the orchard one variable, the vagaries of nature, is as yet far out of the control of man and those engaged in fruit growing can look with some complacency upon the fears of redundancy due to automation so widely voiced in other industries.

Air-blast Vine Sprayer

The Australian Minister for Primary Industry, Mr. McMahon, said recently that he had approved the manufacture of a prototype air-blast sprayer to combat diseases in vineyard fruits.

Because of the difficulties confronting the Australian dried fruit industry, and the need for every possible reduction in costs of production if the industry was to compete in world markets, the Federal Government had decided to finance the manufacture—under Government supervision—of the prototype sprayer for trial and demonstration during the next grape-growing season.

It was hoped that his new vine sprayer would prepare the way for cheaper and more efficient crop protection in this important industry.

Attacks by fungus diseases, such as black spot and mildew, and of insect pests, such as mites, light-brown apple moth, mealy bug and the vine moth, were becoming increasingly serious and the protection of crops required frequent application of chemical sprays. This could be a laborious and costly process.

Spray programmes

Mr. McMahon said: 'Growers have been forced to pay more and more attention to spray programmes and in recent years many have purchased small, high-pressure sprayers fitted with long hoses and hand-operated booms.

'These units are efficient in the actual application of the spray, but need considerable labour to operate them.

'Senior horticultural officers in State Departments of Agriculture think that the problem justifies the development of an automatic air-blast sprayer for use in vineyards.

'Growers agree that a sprayer of this type will be satisfactory and offers the best means of reducing the high cost of vine spraying, so long as the price is not excessive'.

Engineers of the Aeronautical Research Laboratories, Federal Department of Supply, designed the air-blast vine sprayer, which it should be possible to manufacture at a reasonable price.

British Tractors to be Manufactured in India

Negotiations have now been finalised with the Indian Ministry of Commerce and Industry under which the Ferguson tractor is to be progressively manufactured in that country. Standard Motor Products of India Ltd., an associate company of the Standard Motor Co., will undertake production at their Madras plant.

Massey - Harris - Ferguson (India) Ltd. state that they intend to concentrate on the development, design and indigenous manufacture of the agricultural machinery best suited to Indian requirements. Attention has already been given to specialised agricultural implements for wet rice paddy cultivation as well as to trailers, water tankers and irrigation pumps, all of which are now being manufactured by the company in India.

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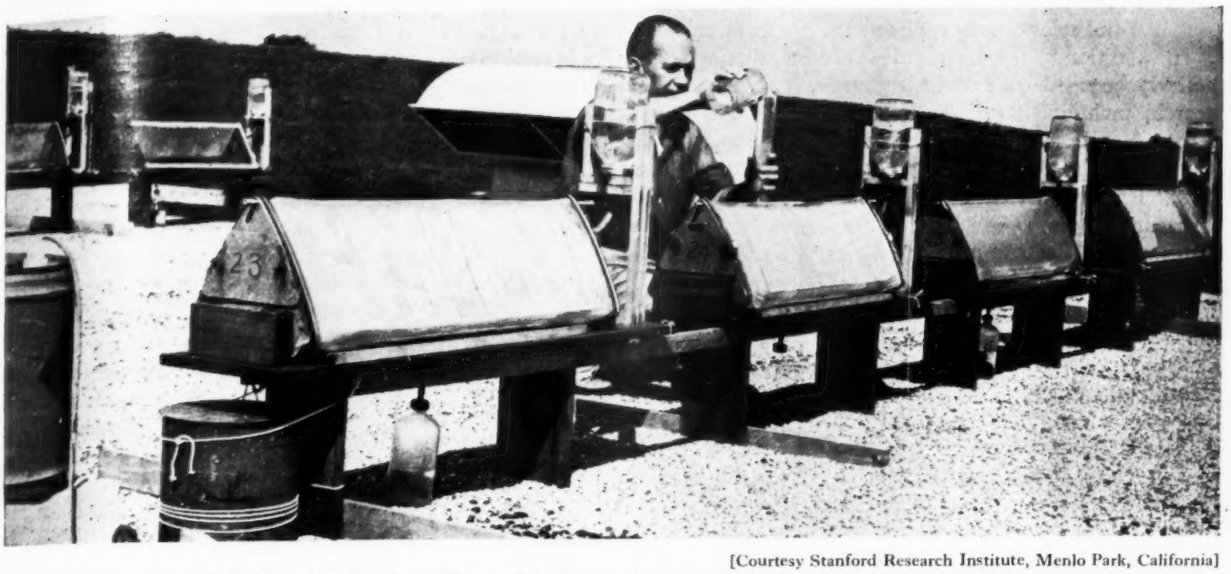


[Courtesy Stanford Research Institute, Menlo Park, California]

Fig. 1. Plastic solar still developed by Bjorksten Research Laboratories Inc., Madison, Wis., U.S.A., to produce fresh water from sea-water by using heat from the sun's rays. Sunlight penetrates the plastic canopy to heat and evaporate sea-water on an inner tray. Vapour condenses on the cool inner surface of the plastic and is drained off through an outlet tap

Solar Energy—I

The Water Problem and its Relation to Solar Energy

A. V. BRANCKER, PH.D.

Since time immemorial man has been confronted with the problem of irregular (and sometimes a paucity of) water supplies for domestic and agricultural purposes. In this series of articles Dr. Brancker discusses the world's food supply in relation to water supply and the possibilities inherent in harnessing the sun's energy for the service of agriculture in particular. A description is given of some of the methods that are already operating, some are only in the pilot stage, others are in full-scale operation.

IN order to maintain adequate health the average person requires food which has an energy value equivalent to at least 3,000 or $3(10^3)$ cal./day.

The world population is estimated to be 3,000,000,000 or $3(10^9)$ and, on this basis, the total calorific requirement would amount to

$3.29(10^{12})$ k.cal./year

or $3.82(10^9)$ kWh.

where 1 kilowatt-hour, kWh. (which has been adopted as a common unit for all forms of energy), equals 860 k.cal. The quantity of solar energy incident annually on the land surfaces of the earth is of the order $246(10^{18})$ kWh., of which some 80%, or $197(10^{18})$ kWh., is available for biological photosynthesis.

The conversion efficiency of green plants, in general, is low and a representative value is 0.2% of an available 80%. It follows that considerable scope exists for improving plant/solar energy conversion efficiencies.

Photosynthesis, where sunlight is transformed into chemical energy and organic matter produced from carbon dioxide and water, occurs in all land plants and also in the green, brown and red algae of the sea. In order to increase the efficiency of this process, a more comprehensive understanding is necessary of the effect of solar radiations on the physical and chemical factors which control plant growth. In this connection chlorella farming and also hydroponics are of particular interest, as they afford methods whereby the variables of solar radiations and nutrient solutions can, to some extent, be studied.

Need for water

No agricultural project, however ambitious, can succeed without ample supplies of fresh water. This was realised by UNESCO almost from its inception. Accordingly, an Advisory Committee on Arid Zone Research was established by this authority and par-

ticular attention was given to the water problem and solar energy applications.

In addition, many countries are actively engaged on solar energy research, including Algeria, Argentine, Australia, Belgian Congo, Belgium, Canada, Cuba, Cyprus, Egypt, England, France, French West Africa, Germany, India, Israel, Italy, Netherlands, New Zealand, South Africa, U.S.S.R. and U.S.A.

Although solar energy is an alternative source of power for regions where conventional fuels are in short supply, it has perhaps the greatest significance in projects designed to produce food in regions hitherto barren and abandoned for many generations.

The interest in solar energy has fluctuated over many years, but increasing attention is being given to this source of power. From the aspect of agricultural projects where provision of water is essential and where sources may be saline, the process of solar demineralisation is of some importance. In Figs. 1 and 2 are shown two simple devices whereby fresh water can be evaporated from salt water; these are batch systems. Under design by the author is a continuous flow system where air, heated by solar energy, is in counter flow to saline water in a packed tower. In what follows an attempt has been made to describe some aspects of solar energy which may stimulate interest and indicate possibilities in agricultural development.

The water problem

What may be termed the water problem has confronted man from very early times. In the Negev of Israel, for example, are the remains of waterwork structures 2,000 years old, by which the Nabataeans maintained a thriving agriculture on an average rainfall of 4 in./year. The methods employed by these people have not been equalled by present-day methods and merit careful study.

In many similar regions the rain occurs suddenly in violent bursts; it rushes over semi-impermeable soil and carries with it a slurry of surface soil, which is deposited over an extensive area to little purpose. If, however, the flood waters can be controlled and the deposition of soil concentrated over small areas, vegetation can be supported even in barren regions. It is, in fact, possible to grow barley, wheat, legumes, grapes, figs etc. in a near wilderness.

Although irrigation is a solution to the water problem in some regions, the waters may contain dissolved salts at a concentration which may exceed the salt and alkali tolerance of the plants. Consequently, there is a need for an economic method of demineralising saline water. Solar evaporation and distillation methods are under investigation for this purpose, but when very large volumes of salt water are involved it would seem doubtful whether any batch pan evaporation system of the type shown in Figs. 1 and 2 can be adequate, except for local operation by individual farmers, where they may be very useful.

Large-scale demineralisation of saline water is a major chemical engineering project which has to be tackled boldly and with imagination.

Of equal importance is water prospecting, or the location of what is termed the water table by geophysical methods. Among these methods may be mentioned seismic sounding, electrical resistivity, magnetic and gravitational surveys. In addition, there are frequently surface indications of water based on certain plants and the reactions of animals. It is debatable whether ' dowsing ' or the use of the divining rod demonstrates a physical radiation from water or a psychic reaction of the operator. In some scientific quarters ' dowsing ' is regarded as unreliable, but it should not be summarily dismissed.

Geophysical methods, each of which merits a separate discussion, by the elucidation of geological structures gives indirect but valuable indications of water: among these the resistivity method is perhaps the best means of determining the presence of the water table. It will, of course, be appreciated that once water is found at depths it has to be lifted by pumps. Where fuel is available conventional pumps can be used, but considerable scope exists for solar pumps in regions where fuel is short and solar intensities high.

Apart from conventional fuels and hydro-electric power, the main sources of energy available for any large-scale agricultural project are contained in winds and nuclear and solar radiations.

Agriculture v. industry

The industrial demands of the future on both conventional and nuclear fuels may be so heavy that little can be expected for food-growing projects in arid regions. In such a case the solution of the food problem for an ever-increasing world population may well depend on the application of solar energy and wind power. In many drainage and irrigation projects the flow of water is sluggish and impulsion is necessary. The possibility of using a high-pressure irrigation scheme which would include pumps, pipes and sprays where the motive power is derived from solar energy or winds merits consideration.

Food potential

The world population, estimated at 2,408 millions in 1950, and now in the vicinity of 3,000 millions, is increasing at a rate which can make competitive demands on food, mineral and energy resources.

Food, equally with coal, oil and nuclear fuels, is a source of energy and man-power, equally with British thermal units or kilowatt-hours, is a factor of importance in the balance sheet of any industrial process or power system. In order to maintain a standard of health necessary for a full day's work, the average adult requires food energy equivalent to 3,000 cal./day.

The food consumption, however, of some 26 countries is below the minimum, which is only exceeded by Norway, Sweden, Denmark, Switzerland,

TABLE 1

FOOD CONSUMPTION[1] 1951–52

CALORIES/HEAD/DAY

Less than 3,000		More than 3,000	
India	1,590	Canada	3,010
Ceylon	1,950	United Kingdom	3,080
Japan	2,130	United States[1]	3,090
Egypt	2,360	Sweden	3,090
Portugal	2,460	Switzerland	3,180
Turkey	2,550	Denmark	3,220
Germany	2,760	Australia	3,280

[1] 1951

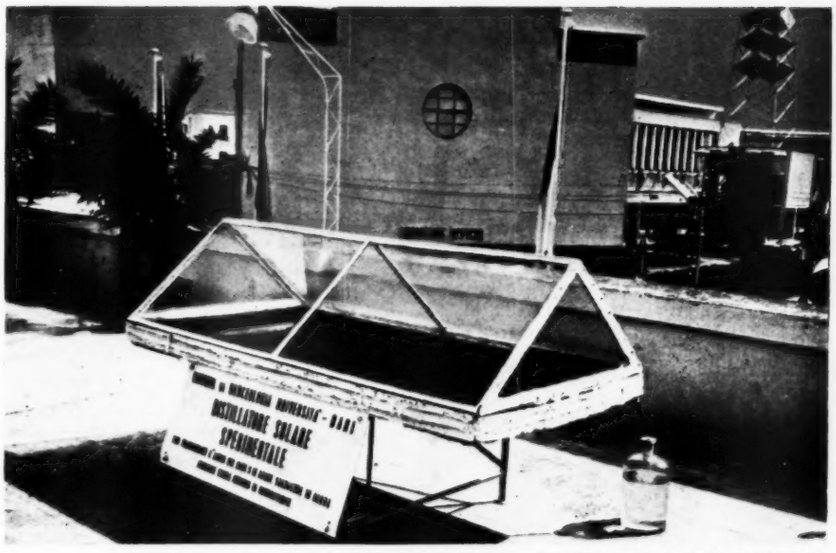
Finland, Iceland, Ireland, Australia, New Zealand, the U.S.A. and the U.K. In Table 1, for example, are given some representative data based on intakes of cereals, potatoes, sugar, pulses, meat and milk; attention is drawn to the low calorific values for India and Ceylon.

Of equal significance are the data in Table 2, where food production figures for 1937 and 1953 are compared.

Although some increases in food production over prewar figures are shown in Table 2, the prospects for the future are by no means promising unless considerable improvements are accomplished.

According to FAO, world agricultural production at the end of the war was down 5% on prewar data and population up 10%. Not until 1954 was the hiatus overcome and a surplus shown in some countries, which, however, others could not afford. Only now are marked increases appearing; about 20% in rice and milk, 30% in wheat, fats, meat, and 50% in fruit and sugar. Even so, in many countries the food consumption per head is far below the standard necessary for health and the spectre of famine has not receded.

In this connection it is appropriate to quote Dr. Candau, Director-General, WHO, who stated: 'We must accept the simple fact that as long as millions of people are unable to satisfy their elementary needs, as long as ill health and ignorance are the normal conditions for the majority of the people of the world, peace and security will remain hollow words'.[2] In similar vein: 'Improved living standards, both in advanced countries like our own and in undeveloped countries overseas, can only come about through the increased use of power'.[3] These opinions are typical of many quoted by various authorities and present a challenge, particularly to engineers concerned with agriculture, irrigation schemes, hydroelectric projects, and power units in general.



[Courtesy Stanford Research Institute, Menlo Park, California]

Fig. 2. Solar still built at the Instituto di Merceologia (Laboratorio Chimico e Museo), Universita-Bari, Italy

In Table 3, for example, are given some population densities ranging from 22,000/sq. km. to unity. If, in the future a solution to the problem of increasing populations is sought in mass emigration from regions of high to low concentrations, then provision must be made in terms of food production and local energy resources.

In few, if any, of the sparsely populated regions are technical developments sufficiently advanced to support a sudden influx of people. In some of these regions the soil is impoverished, droughts are prevalent and erosion serious. In the wet seasons the rain can be of torrential force and further deplete the soil unless impounded. In this connection, of all continents, Africa has the greatest water potential. Not all the rivers are readily diverted for irrigation purposes, but the difficulties of water conservation are, surely, no greater than those of land reclamation met by the Dutch and overcome. Africa, then, can be the site of any industrial or agricultural experiment as great as man's vision for the future; and not only Africa, but also other countries which are rich in natural resources but inhabited by poor people, whose future depends on vast-scale engineering projects and numerous small-scale power units to implement farming operations.

In addition to food production, the processing of minerals depends on ample and cheap power derived from local energy resources.

TABLE 2

WORLD PRODUCTIONS[1] (THOUSAND METRIC TONS)

	1937	1953		1937	1953
Wheat ..	124,700	163,600	Soya beans ..	12 270	17,790
Rye	22,600	21,000	Potatoes ..	192,805	160,300
Maize ..	124,400	144,000	Palm oil ..	520	560
Barley ..	41,000	54,800	Cacao	670	750
Oats	48,600	48,600	Coffee ..	2,600	2,430
Groundnuts ..	8,900	10,800	Tea	463	580[c]
Rice[2] ..	151,200	168,600	Cattle[3] ..	690,000	795,000[c]
Cottonseed ..	14,720	13,300	Pig[3]	294,300	325,200
Linseed ..	2,570	2,500	Sheep[3] ..	730,000	805,000
Fish	12,240	16,496	Milk[4]	179,602	160,136

[1] Excluding U.S.S.R.
[2] 1934-38
[3] Thousand Head
[4] 1952-53
[c] Prewar
[d] Including U.S.S.R.

TABLE 3

POPULATION DENSITIES PER SQUARE KILOMETRE

Monaco	22,000	U.K.	208	Belgian Congo	5
Macao	12,500	India	113	French W.Africa	4
W. Berlin ..	4,642	Egypt ..	22	N. Rhodesia ..	3
Hong Kong ..	2,221	U.S.A.	20	British Guiana	2
Trieste ..	1,332	Gold Coast ..	20	Sudan ..	1
Bermuda ..	736	S. Africa ..	11	Canada ..	1
Tangier ..	527	U.S.S.R. ..	9	Australia ..	1
Kenya	277	S. Rhodesia ..	6	Alaska ..	0

Major energy sources

The main sources of world energy reserves are contained in coal, oil, gas, tar sands, wood, water, wind, nuclear fuels and solar radiations. It may be many years before nuclear power units can contribute substantially and effectively to the energy needs of undeveloped countries and industrial expansion is based mainly on hydroelectric projects and local fuel reserves.

Increasing interest, however, has been shown in solar energy, particularly for regions where fuel is in short supply and insolation of high intensity.

Solar energy

The sun is a sphere of matter of mass $1.99(10^{30})$ kg. and radius $6.961(10^{8})$ m. It behaves as an ionised gas of moderate density which is at a central temperature of some $24(10^{6})$ °K, and a photosphere temperature of 5,930 °K. The energy radiated from the centre is liberated by a cycle of nuclear reactions wherein helium is synthesised from protons; this energy, mainly in the form of *X*-rays at the centre, is transformed to visible light in passage to the surface.

Of the total energy radiated from the sun, the earth's atmosphere intercepts only a fraction, which amounts approximately to $5(10^{21})$ B.Th.U./year. Some $3{,}200(10^{18})$ B.Th.U. are incident at the earth's surface and of $840(10^{18})$ B.Th.U./year which fall on land 80% contribute to biological photosyntheses at an average 0.2% conversion efficiency. These energy values are of considerable magnitude, but practical and economic application of various solar projects which have been proposed depends on conversion efficiencies, particularly in the case of biological processes, such as chlorella farming.

TABLE 4

Latitude	0°	17°	46°	49°	63°	66½°
Hours	12	13	15	16	20	24
Latitude	67° 21′	69° 31′	78° 11′	90°		
Months	1	2	4	6		

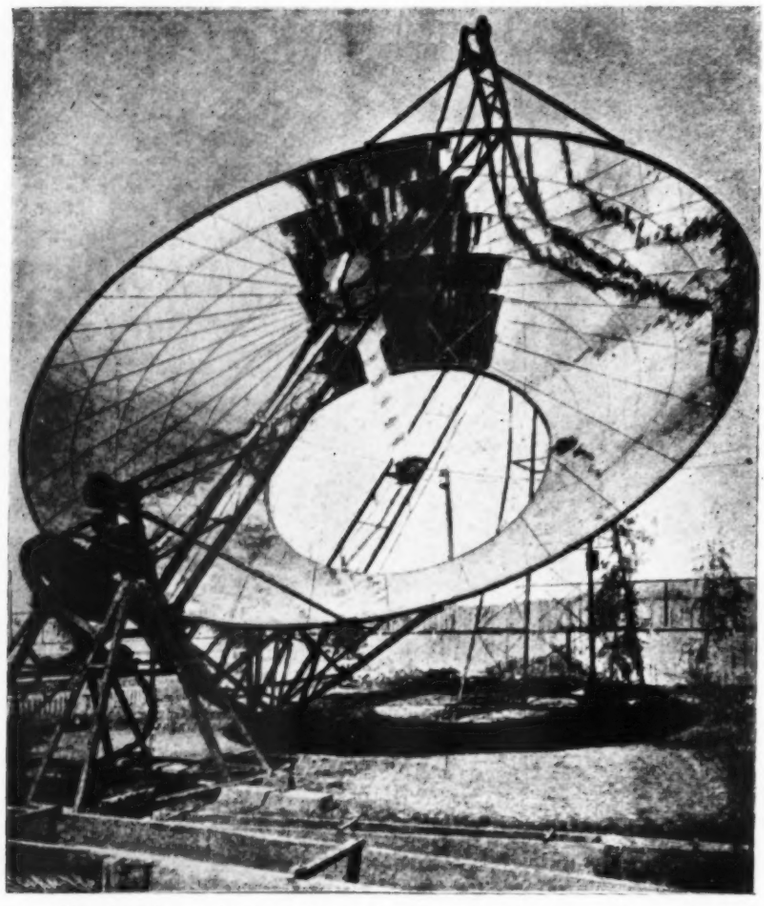


Fig. 3. The Pasadena solar pumping engine (front view). The boiler at the focus is 13 ft. 6 in. long and holds 100 gal. of water. The water lift is 1,400 gal./min.

The quantity of solar energy received at the earth's surface depends on the angle of the incident rays and the duration of the days. In a clear sky the transmission, excluding dust, is a fraction of the air mass m and the radiation received on a horizontal surface is given by

$$dE/dt = (E_0/r^2)q^m \cos Z \quad \ldots\ldots\ldots (1)$$

where E_0 is the solar constant, r the radius vector of the earth, q the transmission coefficient, and Z the sun's zenith distance.

When the sun is at the zenith, $m = 1$ and $Z = 0$ or

$$dE/dt = E_0 q/r^2 \quad \ldots\ldots\ldots\ldots\ldots (2)$$

At the top of the atmosphere, since $m = 0$

$$dE/dt = E_0 \cos Z/r^2$$

In addition, for energy incident at an angle θ measured from the normal

$$E_0 = E \cos\theta$$

From equations (1) and (2) it is possible to estimate the total solar radiation at the top of the earth's atmosphere and at the surface for different latitudes when q is known.

There are, of course, many local factors which determine whether a solar device has a reasonable chance of success or not; one of these is humidity, another the length of day. In Table 4, for example, are given the lengths of the longest days at different latitudes.

At all regions of the same latitude the length of day and angle of the sun's rays are the same and the top of the atmosphere receives the same amount of solar energy. Since, however, climatic conditions vary considerably, the solar energy received will not be the same.

Different parallels or latitudes receive varying amounts of solar energy, decreasing from the Equator to the Poles. Thus in Table 5 are given the quantities of insolation received at the equinoxes and solstices in kWh./sq. dekameter or milliwatts/sq. cm.

It will be seen from Table 5 that the effect of the seasonal changes on the insolation is least at the Equator, most pronounced at 90° N, and radiation is most intense on 20 December at 90° S.

On 22 March and 23 September the sun's noon rays are directly overhead and vertical at the Equator; the great circle of illumination passes through both Poles and cuts all parallels in half. Solar energy is then at a

maximum at the Equator and near zero at the Poles.

On 21 June the North Pole is inclined 23½° towards the sun and the noon rays are vertical at the Tropic of Capricorn; solar energy is at a maximum in the Northern Hemisphere and in the Southern Hemisphere winter conditions prevail.

The foregoing climatic factors can be related to the growing or resting season of crops in various regions when solar energy conversion is at a natural maximum or minimum. In Table 6, for example, are some of the data compiled by Wassink on solar energy conversion for different crops.[5]

Although the conversion efficiencies in Table 6 are low, the data, perhaps, demonstrate in terms of energy the function of solar radiations on crop growth. If, now, the efficiencies could be increased by any means whatsoever to, say, 30%, comparable with industrial processes, the effect would be revolutionary.

In order to obtain such increases in conversion efficiencies it is necessary to improve considerably on nature; in any country this is not an easy proposition, but in some it may be extremely difficult.

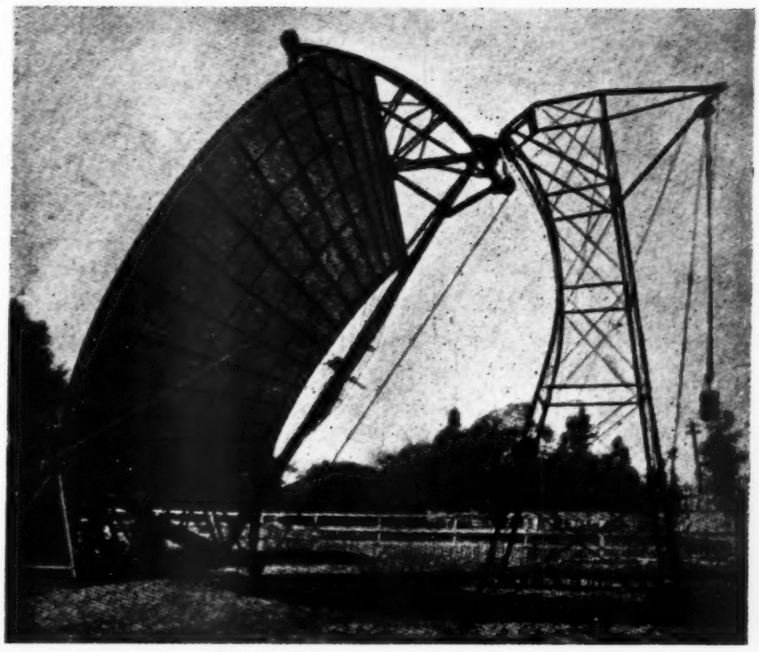


Fig. 4. The Pasadena solar pumping engine (side view). Note the Equatorial mounting

Suitable regions

The regions best suited, perhaps, for solar projects are not necessarily the Equatorial areas, but the tropical trade-wind deserts. The Equatorial atmosphere, in fact, has much water vapour and the solar energy is at a lower intensity than on the trade-wind belt; the Equatorial belt between latitudes 5° N and S is by no means the hottest part of the earth. The temperature, however, at about 90° F. shows little variation and the day is always of 12 hours' duration. Between the Equator and the Tropics are the tropical belts, where the mean average temperature is approximately 70° F., and seasonal changes become more pronounced.

In the Temperate Belts — Sub-tropics, extending to latitude 45°—the winters become colder, but summer heats are not much less than those at the Equator. Baghdad, for example, in summer experiences intense heat with no cloud relief on the arid plains.

The range of temperatures, both annual and diurnal, is greatest in the trade-wind deserts, where the thermometer rises to 120° F. At Azizia, 25 miles south of Tripoli, 136.4° F. was recorded in September 1922 and 134° has been reached in Death Valley, California.

In contrast, the coldest tract in the world is Antarctica, a lofty snow-covered plateau, 7,000–10,000 ft. up, where temperatures fall to –80°. The conditions are anticyclonic, with little cloud, bright starry nights, brilliant aurorae, and winters are followed by long spells of sunshine which average 14 hours a day.

Conditions in the Arctic, as reported, are much less sunny; fog is prevalent and the sun, when visible, appears through mists.

The possibility of solar projects being developed in these cold regions, particularly the Antarctica, cannot be summarily dismissed and the operation of solar cookers would seem to be a quite feasible proposition.

Equally, installations at high altitudes merit consideration, as shown by the solar intensities in Table 6 (*a*).

At these altitudes, of course, absorption by clouds is small and the rarefied air is substantially dust-free, hence high solar intensities can be obtained.

Of the various regions where solar projects may find application, the Sudan is of particular interest. Climatically it applies to a belt which stretches across Africa from Abyssinia to French Guinea and Senegal, whose coasts are embraced by the Atlantic.

The Sudan

Some years ago the Sudan was a harsh country of a severe climate with few relieving features. Yet a land-reclamation scheme over a period of some 25 years has been an agricultural, social and financial success.

The Gezira project, based upon Nile water, despite many difficulties, expanded from 3(10^5) acres in 1926 to 10 million acres in 1952 and is an example of what can be accomplished. Whatever scheme is visualised for increasing food production, an ample and economical water supply is essential. Each plant requires a certain amount of water; yields per acre are

TABLE 5

INSOLATION (KWH. SQUARE DEKAMETRE)

	Equator	20°	40°	60°	90°N	90°S
22 March	1038	980	805	532	30	0
21 June	915	1085	1150	1135	1249	0
20 September ..	1023	972	805	541	20	0
20 December	977	702	371	58	0	1331

TABLE 6

Crop	Growth period	Chemical energy 10^{12} ergs/c.c.	Solar radiation		10^{12} ergs/c.c.	Efficiency %
			Received cal./sq. cm.	Usable cal./ sq. cm.		
Onions	April–Sept.	0.55	58,000	29,000	1.22	0.45
Potatoes	April–Sept.	1.50	58,000	29,000	1.22	1.23
Grapes	Aug.–Nov.	0.56	21,700	10,850	0.45	1.24
Wheat	Nov.–Aug.	1.62	61,000	30,500	1.28	1.26
Sugar-cane	April–March	5.20	129,000	64,500	2.70	1.92

directly related to water/acre and can decline to a catastrophic minima over long periods of drought.

To avoid this disaster extensive irrigation schemes are necessary. In practice this may involve the excavation of channels hundreds of miles long, which is no easy undertaking. Alternatively, the basin system as used in parts of Upper Egypt may be employed; in this case the land is flooded once a year.

In order to move and control large quantities of water power units are essential; those in operation extend from the primitive to the modern, but in regions where fuel is short, as stated above, there is considerable scope for solar pumping units.

An interesting example of an early solar pumping engine, designed by Professor C. F. Holder, of California, is shown in Figs. 3 and 4. The inner surface of the reflector, of top diameter 31 ft. 6 in., bottom 15 ft., was composed of 1,788 small mirrors so arranged that solar rays were reflected and concentrated on a water boiler suspended in the focus. The boiler was 13 ft. 6 in. long and held 100 gal. of water. Steam was generated and this pumping unit lifted 1,400 gal. of water per minute. The application of modern versions of this solar pumping engine, both to irrigation and swamp clearance projects, merits consideration.

Part II of this paper, in the next issue of WORLD CROPS, will include all references.

TABLE 6 (A)

	Height ft.	Solar intensity cal./sq.cm./ min.
Mont Blanc ..	15,000	1.55
Davos	5,120	1.59
Mont Whitney	15,000	1.64
Balloon ..	4,000	1.67

Fruit-growing in Poland

The International Scientific Horticulture Congress held at Skierniewice, near Warsaw, from 23 to 25 May, was the occasion of a gathering of horticulturists from 16 countries. Delegates included Dr. L. C. Luckwill, of the Long Ashton Research Station, Bristol University; Professor R. Ulrich, of the Sorbonne; Professor Porpaczy, the distinguished Hungarian horticulturist; and Professor Z. Mitlitsky, of the Moscow Fruit and Vegetable Processing Institute.

The conference was preceded by some 10 days of visits to the major centres of fruit-growing and pomological research in the country. Delegates visited Grójec (about 50 miles south of Warsaw on the west of the Vistula), Pulawy, Kazimierz and Sandomierz (all on the south Vistula), Lublin, Nowy Sacz and Zakopane in the Tatras, and Poznan. There was particular interest in the work being done at Pulawy on soil fertility and the effect of weather conditions on plant growth, and delegates were much impressed by the results obtained by Professor Stanislaw Zaliwski at the Górna Niwa Institute in the cultivation of low-growing fruit trees.

The Director of the Skierniewicz Horticultural Institute, which was host to the Congress, Professor Szczepan Pieniazek, recently outlined the current state of Polish fruit cultivation. The major fruit-growing areas are in the central and eastern provinces of Rzeszów, Kielce, Lublin and Warsaw.

There are at present almost 40 million fruit trees in Poland, compared with 22 millions in 1945 (approximately 1.5 per head of population). Yields, however, are not yet very high, since up to the war specialised large-scale fruit-growing hardly existed; almost every farmer used to have his own small orchard which was tended without any special knowledge.

Specialisation

By now, however, specialisation in horticulture is well established. There are two main forms. The first is the co-operative farm, with orchards producing fruit for the market; such orchards cover from 40 to over 100 acres. Experts for the management of these orchards are trained in several horticultural schools and in the horticultural departments of Warsaw and Poznan, which turn out about 140 horticulture graduates every year. The second main form of horticultural specialisation is the establishment of fruit-growing groups with no production speciality. Thus several neighbouring farms will establish jointly a large orchard on land contributed by up to 15 farmsteads. Supervision of the orchard, and especially combating of tree pests and diseases, is effected communally. Storage and marketing are also done jointly, but each contributing farmer remains owner of his part of the orchard and of the fruit it yields.

Effective protection against pests has become possible of late years also, through the coming into production in 1954 of the Trojak factory, manufacturing motor sprayers for insecticides.

Viticulture

One of the more interesting aspects of Poland's postwar fruit production mentioned by Professor Peniazek is that of viticulture. In 1945 there were about 200 acres of vineyards in the whole country; there are by now some 625 acres. The country's largest vineyard, of 100 acres, is as far north as Warka on the Pilica, only 50 miles south of Warsaw. Poland is, of course, on the very northern limits of vine cultivation and there are many attendant risks, but the late winter caused comparatively little damage and a good crop is forecast.

The Role of Fertilisers in Rice Production in Tropical and Semi-Temperate Climates

L. J. CARPENTIER

Famine frequently occurs in certain over-populated Asiatic countries where the population feeds largely on rice. Rice fields cover large areas of the world—100 million ha. compared with 130 for wheat and 83 for maize. In Asia especially, wheat covers only 50 million ha. In addition we are at the present time encouraging a rapid development of rice cultivation in the Mediterranean basin, where it seems to succeed perfectly. The growing importance of this crop has prompted the author to assemble and analyse many precise reports on the role of fertilisers in the production of rice.

AT first sight the subject appears difficult, due to the various climatic conditions (quite tropical in Southern Asia, in Africa and Central America, nearly temperate in Japan, China, Australia and in Southern Europe) and the various levels of development of cultural methods (very primitive in India, very modern in the U.S.A. and in France, intermediate in Italy and Spain).

It seems useful, therefore, before dealing with the heart of the subject, to define the present conditions of paddy production and the cultural techniques used. The first chapter will be devoted to this. The second will deal with fertilising and will consist of four parts: the fertilisers presently used in different regions of the world, the needs of this cereal for fertiliser elements, fertiliser experiments carried out in tropical and semi-temperate zones, and finally some advice on fertilising.

Some further information collected from Morocco and Portugal will also be given.

I. Conditions and Principal Characteristics of Production

A—*World production of paddy.*—European rice cultivation is more productive than that in other parts of the world (see Table 1) and the yields in countries with a semi-temperate climate are appreciably greater than those of countries in the tropical zone (see Table 2).

In Formosa, for example, the Japanese have made widely known and have widely used cultural and improved methods, but have not, nevertheless, been able to harvest more than 25 q.(quintals)/ha., whereas in the Mediterranean region 40–50 q./ha. are easily obtained.

Agronomists attribute this considerable difference to the light, which in spring and summer lasts longer and is more intense in the Mediterranean zone than in the tropics. Rice seems to be very sensitive to this natural factor.

This is why they recommend that irrigated rice-fields should be established in the wide, flat valleys or deltas of the semi-temperate regions, irrigation water being provided by rivers or lakes. They consider that the light

Rice-fields in Java. Java and Madura together produced 7,274,000 metric tons of rice (paddy) in 1954

TABLE 1

AREA CULTIVATED, PRODUCTION AND YIELD IN DIFFERENT PARTS OF THE WORLD (IN 1953)

	Area cultivated (in thousands of ha.)	*Production (in thousands of tons)*	*Yields (in q.*/ha.)*
Europe	336	1,670	49.7
North America	1,264	3,030	23.9
South America	2,596	4,600	17.7
Asia	94,400	153,000	16.2
Africa	2,896	3,200	11.0
Oceania	28	110	39.2
Total	101,520	165,610	Average: 16.4

*1 quintal = 1,968 cwt.

factor exercises a much greater effect on the growth of rice than the regularity and abundance of rainfall, the essential reason for the very ancient development of rice cultivation in Asia.

B—*Cultivation methods.*—The human factor also plays a large part: in India, Malaya or Ceylon rice farmers still follow traditional and primitive methods, cultivating with wooden ploughs, reaping sometimes ear by ear (in Malaya, for example) or by sickle (in India).

In the U.S.A. and in Morocco, on the other hand, powerful machinery and very modern methods are used. In Morocco the cultivation processes are carried out by very heavy tractor-drawn ploughs, for the soil there is clayey and impermeable. Each plot is of 2.5 ha., and sowing is done by aircraft, as is also top-dressing. Italy, Spain and Portugal have an abundant labour force, which allows of very intensive cultivation with little mechanical aid. However, both in Morocco and Portugal yields reach on an average 40–50 q./ha. This leads us to compare two different methods both currently used: (1) transplanting, as in China, Malaya, British Guiana (dry nurseries), in Java and in Southern Europe (irrigated nurseries); (2) direct sowing, as in India, Ceylon and in countries with mechanised cultivation.

Transplanting apparently favours tillering, avoids invasion by algae and weeds and enables up to two crops of paddy and one catch-crop to be grown on the same plot. But it requires a very large labour force, for one woman plants on an average only 2 ares (239.20 sq. yd.) a day.

Direct sowing has not this inconvenience, but makes the struggle against weeds and algae difficult. This problem has been solved by including rice in various rotations, which will now be discussed.

C—*Rotations in different parts of the world.*—In India and Ceylon rice is a monoculture (hence the poor yields shown in Table 2).

In China and Japan: two rice crops in summer and one catch-crop in winter (sweet potatoes, legumes etc.).

In California: rice (three years running)/one short fallow/winter wheat or rice/fallow.

In Italy: cereal-temporary grassland (two or three years)/rice (three or four years), or

Maize-hemp or sugar-beet (first year)

Wheat (second year)

Temporary grassland (third year)

Rice (fourth year)

In Egypt: rice (in summer) and clover (in winter)/cotton and clover; or rice and clover/fallow (or maize)/cotton and clover.

In Morocco: rice (three years)/berseem (*Trifolium alexandrinum*).

In this last country, where this crop has been developed recently, the poorness of the productivity at the end of three consecutive years of rice growing and the invasion by algae and weeds has made necessary the introduction of berseem, which improves the soil structure.

From Table 2 it can be seen that the countries with the best yields practise a rotation including a ley.

However, in Portugal at the rice-growing station of Aguas de Moura, paddy crops have been grown continuously for 16 years without decreased yields. There they follow a one-year rotation, namely, fallow (Sept.–April)—rice (April–Sept.) or fallow (Sept.–January)—potato (January–April)—rice (April–Sept.); the catch-crop may also be cabbage or cauliflower. In this country in a mild winter microbial activity is still intense at this period and the soil structure has time to recover. As rice is the most profitable crop, an endeavour is made to have the maximum area available for planting.

TABLE 2

AVERAGE YIELDS IN SEVERAL COUNTRIES (IN Q./HA.)

Semi-temperate and temperate countries		*Tropical countries*	
Italy ..	50	Formosa ..	24
Australia	42	Indonesia ..	15
Japan ..	37.5	India ..	12
Egypt ..	32	Madagascar	12
United States..	23	Ceylon ..	8

However, in the future modern mechanical methods will be used in all newly created rice-fields: planting has big advantages, but up to the present requires too much manual labour. The appearance on the market of improved mechanical planting machines will appreciably lessen the net cost of this operation and the question of choosing between direct sowing and planting will be posed anew. For the moment it is better to sow direct, taking care not to keep a rice-field on the same area more than three years running (see the example of Morocco). A rotation comprising rice for two or three years, a ley for one year or more and possibly another cereal seems to be recommendable.

II. The Fertilising of Rice Fields

(*a*) Fertilisers used

In a large part of the Asiatic countries no mineral fertiliser is applied to the soil. The peasants are too poor to buy fertilisers and are content generally to spread farmyard manure, when they have it, various composts and, most often, to leave the rice straw on the ground. This has been so for many centuries in Malaya, Ceylon and in India. However, in the latter country the Government has introduced a campaign favouring the use of fertilisers by granting subsidies and this policy seems to be successful.

Generally, the mineral fertilisers applied are based on nitrogen and phosphoric acid in equal proportions, with sometimes a little potash.

If Tables 2 and 3 are compared, then for a given climatic zone the greatest productivity is seen to be attained by those countries which use the heaviest fertilising; it is sufficient to compare Japan and India, for example.

Generally, phosphoric acid and potash, as well as part of the nitrogen, are incorporated before sowing or planting, the remaining nitrogen being applied as a top-dressing in one or several applications. For instance, in Japan applications are made either twice (early variety, heavy soil), 80% of the nitrogen before transplanting and 20% 12 days later, or three times (semi-late variety, medium soil), 50% before transplanting, 25% 12 days later, 25% 24 days later, or four times (late variety, light soil), 30% before transplanting, 20% 12 days later, 20% 24 days later, 30% 48 days later. This fertiliser element is most often used in an ammoniacal form.

TABLE 3

AVERAGE QUANTITIES OF FERTILISER ELEMENTS APPLIED IN DIFFERENT COUNTRIES (KG./HA.)

	N	P_2O_5	K_2O
India (Madras)	30	20	—
India (Central)	20	20	—
Japan ..	50–90	35–70	35–50
Thailand	25	50	—
Indochina	10–20	40	—
Bulgaria	30	60	30
Egypt ..	40–75	50–100	—
United States ..	40–80	35–70	—
Morocco	80–100	80–140	little
Portugal	70	80	60
Italy ..	40 (after ley)	150	—

In the rice-growing region of the Rharb in Morocco, on heavy ' tirs ' soils, rather rich in organic matter, with a neutral or alkaline reaction (pH 7.2–8), rich in active lime, very poor in phosphoric acid and well supplied with potash, the fertiliser consists most commonly of superphosphate (400–700 kg./ha. ploughed in) and sulphate of ammonia or urea (400 kg./ha. as top-dressing). Fertiliser outlay reaches Fr. 30,000/ha. per year and the yields obtained reach on an average 40 q./ha.

In Portugal at the rice-growing station the basic fertiliser consists of 400 kg./ha. of superphosphate and 200 kg./ha. of sulphate of ammonia or 400 kg./ha. of basic slag and 200 kg./ha. of cyanamide, and the top-dressing is 150 kg./ha. of ammonium nitrate.

When rice follows potatoes it is sufficient to complete the fertilising of the latter crop: 200 kg./ha. of sulphate of ammonia, 400 kg. ha. of superphosphate, 150 kg. ha. of potassium chloride before planting, and 100 kg./ha. of sulphate of ammonia and 100 kg./ha. of super as a top-dressing. The yields obtained at this station reach 60–65 q./ha., whereas the average for the neighbouring districts does not exceed 40 q./ha.

Rice picking in Thailand. In 1954 the yield of Thai paddy was of the order of 1,260 kg./ha.

(*b*) The requirements of rice in nutrient elements

The submersion of cultivated soils alters their structure and causes tamping; it modifies the processes of evolution of the nutrient elements (removal of soluble elements by leaching) and of fermentation. Rice needs a soil of good physical structure and rich in organic matter. Now it is a question, in general, of tropical or warm temperate regions, where the temperature and humidity accelerate the decomposition of organic matter. This results in considerable need for organic manure or composts. The following paragraph shows the efficiency of farmyard-manure applications.

So far as mineral elements are concerned, it is considered that a harvest of 20 q./ha. of paddy removes 20 kg. of nitrogen, 10–12 kg. of phosphoric acid and 4 kg. of potash. For the same yield the straw removes 20 kg. of nitrogen, 2 kg. of phosphoric acid and 40 kg. of potash. As it usually remains on the ground after reaping, appreciable quantities of nitrogen and especially of potash are returned, but little phosphoric acid.

Besides this, the absence of sulphur causes chloroses, stunting of the plants and defective tillering. At least 10 kg./ha. of this element more than is present in the farmyard manure is necessary, hence the importance of using sulphate of ammonia and superphosphate.

As a large part of the nitrogen is lost

TABLE 4

FERTILISER EXPERIMENT OF 1950–53 AT THE LAKE ALAOTRA STATION

Fertiliser applied	*Harvest in kg./plot of 16 sq. m.*	
	1952	*Average of 4 years*
T = control without fertiliser.. ..	8.71	7.125
A = 3 tons/ha. of rice straw	9.72	7.995
B = rice straw + 250 kg./ha. of sulphate of ammonia	10.19	8.200
C = rice straw + 250 kg./ha. of sulphate of ammonia + 250 kg./ha. of 40% dicalcium phosphate	11.16	8.371

through leaching, appreciably more than the amounts absorbed must be supplied. Phosphoric acid for its part is energetically fixed in tropical soils, which similarly makes necessary applications much greater than the quantities absorbed by the plant.

(*c*) Fertiliser experiments on rice

(1) Experiments in a tropical climate carried out at the Agricultural Station of Lake Alaotra (Madagascar):

Two series of experiments were carried out, one (of four years) on micaceous fluvial alluvium, the other (of three years) on marsh soils.

The first tested fertiliser formulae and gave the results shown in Table 4.

This table shows, firstly, the efficiency of incorporating rice straw, for experiment A is significantly better than the control. There are also significant differences between C and A in favour of C, even more striking in 1952, a year of higher yields. Primarily, then, it is important to apply a heavy basal organic manure completed by a phospho-nitrogenous mineral fertiliser. The 1952 experiment proves the importance of the N/P balance.

Further experiments over four years have made it possible to compare various types of organic fertilisers with and without P_2O_5 and N, *viz.* manure, green manure or rice straw. One plot was fertilised with a complete mineral fertiliser. In this case farmyard manure clearly seems more efficient than the two others; the treatment with farmyard manure alone (without mineral elements) and the complete mineral fertiliser N-P-K gave similar results.

Further experiments (of three years) dealt with different formulae of mineral fertilisers with and without farmyard manure; all the treatments were significantly better than the controls and are classified in the following order: farmyard manure + N P K, farmyard manure + N P, N P and N.

It can be deduced from this collection of results that, in alluvial soil of tropical regions, a massive organic manure application is sufficient to improve appreciably the fertility of rice-fields. It can be completed by a nitrogen mineral fertiliser or, better, a phospho-nitrogenous one, the most efficient and most profitable in this soil type.

Thanks to these fertilisers, a yield increase of 12–14 q./ha. and per year can be anticipated.

The mineral fertiliser experiments on marsh soils lasted two years. The results are given in Table 5.

It can be concluded from this table that:

(*a*) The balance 2N 2P K is clearly more efficient than the others, thus the heaviest fertilising is the most productive.

(*b*) There is little difference between the formulae N 2P K, N P K and 2N P K, which are significantly inferior to 2N 2P K. Thus there exists an interaction between nitrogen and phosphoric acid, whose optimum ratio is about 1 : 1.

(*c*) There is a big drop in yield when one of the three elements is withheld: the presence of K is necessary as well as N and P.

(*d*) The binary fertilisers produce yields significantly superior to those of the control. This experiment demonstrates the importance of fertiliser balance and of the interaction between the elements N, P and K on marsh soils in tropical climate.

(2) Experiments in a temperate climate in Japan:

Experiments carried out at 10 experimental stations have allowed the relative values of different formulae compared with a complete fertiliser to be established:

N P K	P K	N P	Control
100	59	94	54

As in the preceding examples, nitrogen is the limiting factor, and by associating it with phosphoric acid it is possible to obtain a maximum yield.

(3) Experiments in a Mediterranean climate:

In the South of France some experiments have been carried out, whose results are given in Table 6.

TABLE 6

INDEXES OF COMPARISON OF RESULTS OF FERTILISER EXPERIMENTS CARRIED OUT IN THE CAMARGUE IN 1949–50

Fertiliser used	*Relative*
Control	100
P K without N	88
P K + 300 kg. sulphate of ammonia	129
P K + 300 kg. cyanamide..	148
40 tons artificial manure without fertiliser ..	139
40 tons artificial manure + 300 kg. cyanamide + P + K	150

P = 600 kg./ha. superphosphate
K = 200 kg./ha. potassium chloride

Once again the predominant role of the organic fertiliser, which must be completed by a balanced mineral fertiliser, is established.

These experiments have clearly shown the importance of nitrogen fertilisers and the superiority of cyanamide over sulphate of ammonia. The Americans, on the other hand, found that the best form of nitrogen was anhydrous ammonia.

In Morocco the importance of organic manure has been demonstrated experimentally. In 1952 a farmyard-manure application raised the paddy yield from 40 to 60 q./ha.

In the same year a fertiliser experiment on slightly alkaline soil showed the superiority of sulphate of ammonia and cyanamide over the other nitrogen fertilisers. It proved further that on an already old rice-field—four years old—nitrogen fertilising by itself causes a disequilibrium, which affects yields, but which is avoided by a complementary phosphate fertiliser.

(*d*) The importance of different fertilisers

(1) *Organic manure.*—There is no need to emphasise the essential role of organic manure in rice growing after having given the results of a number

TABLE 5

FERTILISERS USED AND RESULTS OBTAINED IN THE EXPERIMENTS ON MARSH SOILS

Meaning of symbols	*Amounts and ratios used*	*Yields obtained in kg./plot of 25 sq. m.*
N = 150 kg./ha. of sulphate of ammonia, 20% N	2N 2P K	10.64
	N 2P K	8.80
	N P K	8.77
P = 200 kg./ha. of dicalcium phosphate, 38% total P_2O_5	N P 2K	8.47
	2N P K	8.322
	N P	7.077
K = 100 kg./ha. of potassium chloride, 56% K_2O	N K	6.833
	P K	6.577
	Control	5.755

of fertiliser experiments, which are quite conclusive in this respect. The Japanese, excellent rice farmers, are well aware of this: they always incorporate farmyard manure before transplanting and then apply to the surface 1,000 kg./ha. of a compost obtained by mixing crop residues, night soil, manure etc.

It is advisable to apply 30 tons/ha. of farmyard manure before each crop.

(2) *Nitrogen fertilising.*—In the preceding section emphasis has been laid on the idea of nitrogen as a limiting factor and also on that of the superiority of ammonium to nitrate fertilisers.

Grist gives the following explanation, based on research carried out in Japan. Oxidation and reduction phenomena of the submerged arable layer modify the normal process of nitrate conversion, rendering it unusable. In fact, the surface layer, in contact with the air or with water quite rich in oxygen, remains oxidising. But the oxygen does not penetrate into the deeper layer, which remains reducing. If, therefore, a nitrate is top-dressed, it quickly reaches the reducing layer, where it is reduced to nitrite and then to gaseous nitrogen, in which form it becomes lost. If the same is done with sulphate of ammonia, the latter is first oxidised to nitrate, which is then reduced in the lower layer, 70% of the nitrogen being lost in this way. If the ammonium fertiliser is incorporated directly into the reducing layer, oxidation is avoided and the fertiliser remains assimilable. The Japanese, therefore, recommend an application of ammonium nitrogen at depth shortly before transplanting. Consequently, with split applications it is best to use ammonium fertilisers at the beginning of growth, and the final application may be in the form of nitrate.

We advise an annual application of 300 to 400 kg./ha. of sulphate of ammonia given as several applications: 100 kg. before sowing or transplanting, 100 or 200 kg. before tillering and 100 kg. between tillering and heading.

(3) *Phosphoric acid.*—Various experiments have shown that phosphoric acid is an indispensable supplement to nitrogen fertilising in order to maintain yields after several years of cropping and with sufficiently early ripening.

(*Continued on page* 360)

Cultivating wet paddy in Siam with a Howard ' Rotovator Gem '

New Plough Factory

The expansion of Ransomes, Sims and Jefferies Ltd. over the last 20 years has been very rapid and, in order to keep pace with the increasing demand for their products all over the world and to satisfy modern needs for first-class working conditions and amenities, the works are being gradually transferred to another site. As no land was available in Ipswich, 266 acres were bought at Nacton, just outside the town, and production began when the foundry was established there in 1948. A new plough works was the next building to be erected, and production began there in January 1955.

Since production began over 30,000 implements have been made there. It now provides the entire range of F-R implements manufactured under the agreement with Ford Motor Co., as well as the Ransomes range.

Interior view of Ransomes' new Plough Works, Nacton, showing the assembly lines moving to the paint-spraying section

Work of the Colonial Development Corporation

H. NUTCOMBE HUME, C.B.E.
(Deputy Chairman of the Colonial Development Corporation)

Earlier this year the author read the Thomas Holland Memorial Lecture before the Commonwealth Section of the Royal Society of Arts in London. Few people realise the magnitude of the Corporation's work and the successes that have accrued during the last 18 months. The following article is a condensed account of the original address.

FIRST of all let us be clear about the Corporation's *raison d'être*. The actual words of the Overseas Resources Development Act, 1948, Section I, state that the Corporation is

> 'charged with the duty of securing the investigation, formulation and carrying out of projects for developing resources of colonial territories with a view to the expansion of production therein of foodstuffs and raw materials, or for other agricultural, industrial or trade development therein'.

In the discharge of this duty the Corporation is expressly empowered to carry on, or to promote the carrying on, of all activities which appear to be ' advantageous or convenient for or in connection with ' it. If this piece of Parliamentary drafting is analysed, it will be seen at once how wide is the range of the Corporation's opportunities and responsibilities, especially bearing in mind the geographical spread and diverse character of the British colonial territories.

First—' investigation '; then ' formulation '; then ' carrying out '. ' Expansion of production of food and raw materials '; ' other agricultural, industrial and trade development '. This is indeed a comprehensive mandate!

The method

The powers given to the Corporation in Section I of the Act left a sensibly wide discretion as to the methods by which its manifold tasks could be tackled. The Corporation can carry out development, including the processing and marketing of products, itself under its own direct management; it can establish or expand other bodies to do the work; or it can work in partnership with, and delegate management to, other bodies whether private enterprise or government authorities.

The means

The Secretary of State for the Colonies is authorised to advance to the Corporation sums the total of which outstanding at any one time does not exceed £100 million, and the Corporation is also empowered to borrow up to £10 million on short term. These loans form the capital of the Corporation and interest on them is payable in accordance with rates prevailing at the date of each advance. The Corporation is by the Act required to ensure that its revenues are sufficient to meet its outgoings taking one year with another.

Commercial basis

I would like to emphasise this commercial discipline under which the Corporation has to work. It marks the fundamental difference between the C.D.C. and the Colonial Development and Welfare Fund. There has been some confusion in the minds of some people, both overseas and at home, as to the respective functions of these two instruments.

Money provided by Parliament under the Colonial Development and Welfare Acts (C.D. & W.) is used primarily to further colonial development of a non-commercial character. Projects financed by this means are those which, in the main, are not expected to show a financial return; their aim is rather to lay the essential foundations for wealth creation—communications, scientific research, public utilities, education, health services, and so on.

C.D.C. is an entirely separate organisation; none of its funds come by way of grant moneys and its projects must be such as will ultimately earn revenue to cover the payment of interest and repayment of capital on the terms mentioned above. It will be seen, therefore, that in selecting projects and in operating them C.D.C. must follow normal commercial principles and practice. Within, and inseparable from, the overall task of helping each territory to develop its economy profit must be an essential criterion.

Having described the Corporation's task and the essential conditions under which it is being tackled, I must go on to say something of the achievements and failures so far; also something of the lessons that have been learned. I think it will help to understand the picture more clearly if I first say a brief word about the Corporation's administration and about its relations with local colonial governments and people.

Organisation

The Board of the Corporation consists of a Chairman, Deputy Chairman and not less than four or more than

TABLE I

	Number of projects	*Percentage of capital deployed*
Agriculture ..	12	20.0
Animal products	6	5.4
Factories ..	6	6.7
Fisheries ..	1	0.3
Forestry ..	5	12.0
Hotels ..	1	0.7
Minerals ..	10	12.9
Property and housing ..	7	11.1
Power	7	26.4
Transport and communications .	8	4.5

10 other members, appointed by the Secretary of State for the Colonies 'from amongst persons having had experience of and shown capacity in matters relating to primary production, industry or trade, finance, science, administration, organisation of workers or welfare'.

Board members, including the Chairman and Deputy Chairman, serve on a part-time basis. The chief full-time executive officer, appointed by and responsible to the Board, is the General Manager. Under him at Head Office there are controllers with functional responsibilities for investigation, finance and operations, each with a staff of experienced assistants. Overseas six senior executives are controllers of regions and are responsible for all Corporation activities within their respective areas.

Geographical regions

The regions into which the Corporation's projects are grouped follow naturally from the geographical disposition of the colonies themselves. There is first the Caribbean Region, which, of course, includes all the British West Indies islands, the two mainland territories of British Guiana and British Honduras, and also the Bahamas.

There is the Far East Region, which at present has projects in North Borneo, the Federation of Malaya and in Singapore, but which would also include Brunei, Sarawak, Hong Kong, Fiji and the Western Pacific Islands should projects be launched in any of those territories.

Then there are four regions in Africa. The East Africa Region, with headquarters in Nairobi, has projects in Kenya, Tanganyika and Uganda, and would also include Mauritius, Seychelles and Zanzibar. The West Africa Region covers the four British West African territories of the Gambia, Gold Coast, Nigeria and Sierra Leone; its office is in Lagos. There is a separate Central Africa Region for the Federation of Rhodesia and Nyasaland, and finally a Region, based for convenience in Johannesburg, for the High Commission Territories, Basutoland, Bechuanaland Protectorate and Swaziland. One project outside any region is the Tristan da Cunha Development Co. Ltd., which is dealt with from London through the office of the company in Cape Town, but which in our reports is grouped with the High Commission Territories Region.

Early stages in the construction of a weir on the Komati River, Swaziland, in connection with C.D.C.'s large irrigation scheme. Successful crops of rice are already being grown. Citrus is progressing well; sugar-cane has shown encouraging results and experiments are continuing with other crops

Local association

There is a negative provision in the Act which says that no project shall be encouraged in any territory until there has been adequate consultation with the local government concerned. This, of course, is only common sense and, in fact, quite apart from any statutory obligation, the Corporation has always maintained the closest possible liaison and consultation with colonial governments.

It is also the responsibility of Regional Controllers to see that good relations are maintained with local people and local interests. It is deliberate policy of the Corporation, wherever possible, to enlist the active participation, both financially and in management, of local interests, whether governmental or private enterprise or both, in its projects.

I want to say a special word about management later, but let me say here that wherever there are reliable commercial firms who have long experience, and an established organisation for dealing with any particular line of development, we try to bring them in. C.D.C. is neither private enterprise nor government department; it can render useful service as intermediary, stimulating private enterprise and experience, and linking them with public resources and endeavour.

Physical achievements

There are at present 63 projects in hand, for which a total of nearly £55 million has been sanctioned. Of this sum, over £37 million has already been advanced and used.

It is not possible to go through every one of the 63 projects and describe them all in detail. They are all described and reported upon in the Corporation's Annual Report to the Secretary of State for the Colonies, which is available from H.M. Stationery Office.

Functional grouping

The functional diversity of projects is shown each year in the Annual Report by a table giving the proportions of capital approved and capital

employed under various heads. The functional grouping and proportions are approximately as shown in Table 1.

As the economy of practically every colony is based on primary production, it is not unnatural that agriculture, animal products, forestry and minerals account for more than half the projects. But it will be seen that there is a fair balance of investment in those projects which will stimulate further development such as those for power, transport and communications.

Stages of development

Broadly speaking, the phases through which development projects have to pass are:

(*a*) research and/or exploration;
(*b*) investigation and/or prospecting;
(*c*) test by pilot scheme;
(*d*) development from pilot scheme to full-scale operation;
(*e*) commercial operation.

The Corporation cannot normally provide finance for general research and exploration, but at whatever stage a proposal is brought to the Corporation it is essential, before any major financial commitment is made, to know that the initial stage of investigation has been adequately done and that there is definite prospect that the project is likely to become commercially viable. Sometimes we have to start right at the beginning and on other occasions a certain amount of preliminary work has been done; but there are no occasions on which it can be dispensed with.

Full-scale production may not be reached until the project has been in production for some years. The period of initial trading, which itself may follow a long period of investigation and development, is a testing time for most new projects; losses at this time may quite reasonably be expected on a project that will ultimately be successful, and such losses can properly be regarded as part of the capital cost.

Let us now look at the regions and one or two of their projects to see how they are contributing to development.

Caribbean Region

There are 18 projects in the British West Indies, British Guiana and British Honduras. The total capital employed in projects in this region is £6.5 million and a further £1 million has been sanctioned.

Primary production is being developed by gold, timber and rice projects in British Guiana, by the small but successful banana and copra estate in Dominica, and by a loan to the Citrus Growers Company in Jamaica to finance an extension of its fruit-processing factory. A cooling store built and operated by the Corporation in Kingston is also proving of considerable benefit to Jamaican producers.

A problem that has proved extremely difficult and which has given the Corporation great anxiety is the search for commercially viable means of helping the economy of British Honduras. A stock farm and a banana plantation were both, for varying reasons, unsuccessful and had to be discontinued. Similarly long and exhaustive, as well as expensive, trials have been made into the commercial production of ramie fibre; this also has been discontinued largely owing to the failure of the world market for ramie. Trials are, however, continuing in British Honduras with citrus and, on a small scale, with cocoa. Whether these can be developed beyond the pilot scheme stage will depend on the experience to be gained over the next few years and on the availability of labour.

Far East Region

The Corporation's projects in the Far East are in the Federation of Malaya, Singapore and in North Borneo. Proposals for projects in other British Far East territories have been examined from time to time, but none has yet been found that was commercially practicable.

Other projects helping to relieve Malaya's undue dependence on rubber and tin are an oil-palm estate, where, unfortunately, progress has been hindered by the activities of bandits, and a pilot scheme for cocoa in partnership with a well-known planting firm and one of our leading cocoa firms. The cocoa pilot scheme has made good progress and is now on the threshold of considerable expansion to the commercial production stage.

In North Borneo the Corporation is developing former Japanese-owned rubber and hemp estates. There is a shortage of labour and this, together with a very worrying plant disease in the hemp, has made progress difficult, but the rehabilitation and modernisation of the estates are being pressed forward and new crops are being tried.

East Africa Region

Capital sanctioned for projects in East Africa amounts to £13.3 million; the amount employed at the end of 1955 was £7.9 million.

A valuable contribution to Tanganyika's development is the wattle-growing scheme at Njombe. Here some 30,000 acres are being planted with black wattle, the bark of which is used

A nursery of young seedlings at the Colonial Development Corporation's Kulai Oil Palm Estate, Malaya

for the production of tanning extract. Alongside the Corporation's own estate the local Africans are being encouraged and helped to grow 20,000 acres of their own wattle. A processing factory is now being built and the project will result in the introduction of a new crop and a new industry to an area where Africans previously were barely able to sustain themselves on soil which, though good for wattle, is very poor for food crops.

Central Africa Federation

Development of the plantation projects in Nyasaland has gone forward, but their ultimate success will depend very largely on the provision of communications and the securing of markets.

The total of Corporation capital now sanctioned for development in the Federation is £6 million, of which £2.3 million has already been employed.

Young cocoa trees in Malaya. In association with Harrisons and Crosfield Ltd. and Cadbury Bros. Ltd., C.D.C. has participated in a pilot scheme in Trengannu. Experiments have justified expansion to a commercial estate, initially of 300 acres

High Commission Territories

As yet the Corporation has no project in Basutoland. This is not because this protectorate has been neglected; one or two proposals have been suggested, but there have been none so far that have been found suitable for the Corporation's participation. In the other two territories, however, Bechuanaland and Swaziland, the Corporation has a total of £9.7 million sanctioned, of which £5.4 million has been employed.

The major economic activity in Bechuanaland is, of course, the cattle trade and the Corporation is stimulating this by the development of ranching and by the *abattoir* at Lobatsi, which has introduced a useful and profitable industry to the Protectorate and enabled it to retain the proceeds from processing and by-products which formerly went to neighbouring territories.

By its large irrigation and afforestation projects in Swaziland the Corporation is helping that little country to make more fruitful use of its plentiful rivers and fertile land. Large areas of bush have been cleared, new crops are being introduced and the hills are becoming covered with pine trees, which open up the possibilities of eventual pulp and lumber industries. All this means that the problem of a railway and better road communications for Swaziland is becoming increasingly urgent.

West Africa Region

The Corporation's activities in West Africa are at present confined to Gold Coast and Nigeria. There is a loan to the Lagos Executive Development Board for land reclamation and development. The Corporation is helping in the utilisation of Nigeria's timber resources by its participation in Ome Sawmills of Nigeria Ltd., which operates a new modern sawmill in the Western Region. Capital sanctioned for these projects to date is nearly £3 million, of which £2.5 million is employed.

Financial results

I am not, here, going to give a detailed financial account with a lot of figures. For those who are sufficiently interested the accounts are published every year in the Annual Report. The Corporation is very conscious that it is using public money and that through Parliament it has a responsibility to the British taxpayer.

The Corporation was never expected, and never intended to be, an organisation for making large profits. Nevertheless, it is expected in due time to pay its way. The requirement in the Overseas Resources Development Act is that the Corporation must manage its affairs so as to secure that its revenues are sufficient to meet all charges to its revenue account, ' taking one year with another '. This means that over a reasonable period the Corporation must earn sufficient to meet all its charges, including repayment of capital and payment of interest.

From the Corporation's start in 1948 until 1955 there has, in fact, been a deficit every year, but as a result of ruthless pruning of hopeless projects and by careful retrenchment and reorganisation of some others the annual deficit has been greatly reduced in recent years until in 1955 the Corporation is able for the first time to show a surplus on the year's operations. Financially, the Corporation has now turned the corner and, with careful and realistic management its financial position should show an increasing improvement in the years ahead. This must also be remembered: the Corporation has been acquiring and developing some useful assets which will in time show a favourable return in the profit and loss account as well as contributing to the economies of the colonies in which they have been established.

I am convinced that any Corporation engaged in colonial development, or any other form of enterprise, is a much more useful instrument if it makes

profits than is one which fails to maintain its capital intact and to serve that capital with interest or dividends.

Lessons learned

I do not deny that the Corporation has had its failures, but we are recovering from them and they have taught many useful lessons both for us and for others. The Corporation was set up with no guiding precedents in a period of acute postwar human and material shortages; it had to create a new machine for a task which, in extent and variety, was entirely new.

There is in the world today a widespread urge and a vital need to develop the under-developed areas of the world; but one thing is clear, there can be no short cuts to development, particularly in tropical countries. If projects are to be economically sound and worthwhile, there must be a cautious and realistic approach. In this respect the commercial discipline under which the Corporation works is salutary. Proposals for immediate large-scale development must be looked at with much scepticism. There must often be several years of patient experimentation and trial before it can be known that a given crop or a mineral can be produced on a worth-while scale.

Particularly in the tropical agriculture which is the basis of many colonies' economies, too little is known about the soil, about plant and animal diseases and about the vagaries of climate and rainfall for large schemes to be launched successfully in a hurry. A great deal more has yet to be learned about the economies of mechanised agriculture in the tropics. Land-settlement schemes often look attractive socially and politically, but so long as the Corporation is required to work on a strictly commercial basis, or unless there can be introduced an element of non-returnable finance, such as C.D. & W. grants, such schemes will generally be outside the Corporation's field.

Another outstanding factor in colonial development that I would emphasise is the vital need for honest and competent management on the spot. There are not enough qualified and competent men of the right calibre for all the jobs that want doing. Wherever appropriate, the Corporation seeks to bring in an established private enterprise who already have a tried organisation and an experienced staff to act as managers, but even this is not universally successful or always necessary. The long-term alternative is for the Corporation to build up a trained staff, but again this cannot be done in a hurry.

The future

Some projects launched three, four or five years ago are now reaching the stage of development at which decisions have to be taken as to the further stages that must follow so that the early development work can yield fruit. For example, the utilisation of the timber from the great afforestation scheme in Swaziland, the processing of bark from the Tanganyika wattle plantations the further development of the Nyika Forestry Scheme and a number of mineral developments are all being carefully planned, in many cases in co-operation with already arranged commercial associates and with governments, so that they can eventually make their full contribution to increasing colonial primary products. They will, of course, need further outlay of large amounts of capital, not all of which will necessarily be supplied by the Corporation.

The orderly progression of such schemes from stage to stage is just as important a part of the Corporation's duties as the starting of new schemes. Even if no new schemes are started, the Corporation has enough development work in prospect to keep it busy for a long time. Nevertheless, many new proposals are continually undergoing careful examination.

Although the Corporation has now been established for eight years, it feels as it looks at the task ahead that it has only just begun. There are some 80 million people in the British colonies, protectorates and dependent territories, all in various stages of political, social and economic development. Speaking as Colonial Secretary in 1951, Lord Chandos said:

> 'First, we all aim at helping the colonial territories to attain self-government within the British Commonwealth. To that end we are seeking as rapidly as possible to build up in each territory the institutions which its circumstances require. Second, we are all determined to pursue the economic and social development of the colonial territories so that it keeps pace with their political development'.

This is a great and exciting task; we in C.D.C. are proud to be taking some part in it.

This extract from the original address is reprinted, with permission, from the *Journal of the Royal Society of Arts.*

Photos: C.D.C., London.

Technical News

The September issue of *Dairy Engineering* will include articles on 'In-crate Bottle-washing and Milk Treatment' and 'A Roller Drying Plant in Australia,' by C. V. Barker.

Food Manufacture for September contains articles on 'Sago-flour Dressing,' 'Trace Elements in Foodstuffs —III: Selenium' by C. F. M. Fryd, B.SC., A.R.C.S., A.R.I.C., 'Perishability of Foods in Consumer Packages' by C. Olin Ball and 'Substitute and Synthetic Foods' by D. S. Bhattia and G. S. Bains.

The contents of *Corrosion Technology* for September includes articles on 'The Cost of Corrosion' by Prof. H. K. Worner, 'The Corrosion of Aluminium in Proximity with Iron' by C. E. Bird and U. R. Evans and 'A Gaseous System of Corrosion Control' by Arthur D. Little.

Articles in the September issue of *Petroleum* include 'Advances in Ethylene Production — II,' and 'Hydrogen Attack on Mild-steel Equipment'.

Rice Borer in Pakistan

One of the biggest campaigns against rice stem borer, covering about 225,000 acres, is now in progress in Gujranwala district, by the Director of Agriculture, West Pakistan, in collaboration with the Department of Plant Protection. This insect has caused wide damage to crops in this region.

More Farm Tractors

FAO has reported that an increase of tractors on the world's farmlands of nearly 500,000 a year, to a current total of 7,100,000, is displacing horses and mules, but not camels.

Before the second world war there were 74,700,000 horses in the world; by 1953–54 the number had dropped to 59,100,000, the mule population during the same period dropping from 18,400,000 to 15,600,000.

Camels, used as pack and draft animals in Asia and Africa, increased from 7,800,000 before the war to 9,700,000 in 1953–54.

Some Difficulties in Field Experimentation with Cocoa on the Gold Coast

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Some of the difficulties that beset field officers in planning experiments, both yield and cultural, for the cocoa-growing areas of the Gold Coast have been outlined. The author was able to obtain first-hand knowledge of the difficulties involved when he was invited by the Director of the West African Cocoa Research Institute to assist him to review the programme of field experimentation. This article summarises his observations.

DURING the past 30 years a great many experiments have been initiated on all kinds of agricultural crops, many of which have been carried to a successful conclusion. Most of these experiments have been designed to give a valid estimate of their errors, which have, however, varied very greatly with different crops. Partly because fewer experimental plants are used and partly because of their longevity, the errors of field trials with perennial plants are usually higher than those with annuals. About 25 years ago the writer listed some of the sources of error inherent in the plants and due to exterior causes that the experimenter with fruit trees might expect to encounter.[1] Much more recently Pearce has described some of the mishaps that may occur in a long-term experiment and has discussed statistical means of dealing with the incomplete data that may result.[2] Nevertheless, it may be just as well to emphasise that these are but expedients and a tree or plot that is lost can never be replaced, the experiment suffering according to the number of such losses that occur.

The sources of variation that have been discussed in these publications and, indeed, in many others may affect any regularly planted perennial crop, be it apples, citrus fruits, tea or oil palms, the differences being only those of degree according to the standard of knowledge of the culture of the crop concerned and the conditions of the experiment. As far as possible, the last have been carefully selected so that quite unsuitable land or highly variable plants are not used.

Some critical experiments on the culture of cocoa have been carried out, especially in Trinidad; in these the cocoa trees have been regularly spaced in the same way as many others grown for their fruit in tropical countries. Since the beginning of the present century, however, an increasingly large proportion of the world production of cocoa has been grown in West Africa, particularly the Gold Coast, and, despite the ravages of disease, this country is still a very large producer of this crop.

The conditions that have proved most suitable for production in the Gold Coast, however, have been found in the rain forest areas, in which cocoa, regarded without question as a shade-loving plant, has been planted in smallholdings by peasant farmers on land owned by tribal communities, in heavy bush and under the shade of sometimes very large forest trees. There has been, at any rate until recent years, no orderly spacing of the trees, no cultivations other than the gradual reduction of the surrounding bush and very little attempt at disease control. Indeed, it is believed by some that any cultivation that would result in the disturbance of the soil might be deleterious. Under such conditions farmers have seen no need for manuring, which they regard as an unnecessary expense. Most of the cocoa has been of the Forastero type, known as Amelonado, reputed to have been originally intro-

Fig. 1. Secondary bush in the 'Square Mile' at the West African Cocoa Research Institute, Tafo

duced to the coast from the island of Fernando Po, where it had been planted by the Spaniards in the 17th century.

Gold Coast production

By 1935 the Gold Coast was responsible for about one-third of the world production of cocoa, but since that time it has become apparent that all was not well, outbreaks of the swollen-shoot virus disease being responsible for a great reduction in the acreage under the crop.

This calamity was mainly responsible for the start of research on cocoa in the Gold Coast and at the Central Cocoa Research Station, founded in 1938, and the West African Cocoa Research Institute, which succeeded it in 1944, situated in the Eastern Province in the heart of one of the badly infected areas, much of the original research effort was directed towards the elucidation of the causes of this disease, its vectors and control measures.

At the same time and in the following years, however, other investigations were initiated at the Institute, particularly into the introduction and breeding of improved varieties, the incidence and control of other diseases and pests and cultural methods.

In the investigations that were then started the basic methods of growing cocoa in the Gold Coast were accepted, *i.e.* that it must be planted on undisturbed land under shade. The field trials were placed entirely on land on which secondary bush had been allowed to grow up among the original large forest trees, from which the earlier cocoa trees had been cleared because of swollen shoot disease (Fig. 1). It is true that, in these trials, regular spacing, in so far as the incidence of forest trees allowed, was attempted; indeed, in several trials differential spacings both of Amelonado and the newer introductions have been compared and trees grown by the traditional method of sowing three seeds per picquet, or stake, and thinning the trees to one in the early years have been compared with seedlings grown in the nursery under controlled conditions and with clonal varieties grown from cuttings.

None the less, it must be realised that these early experiments have had to be carried out in the face of variations with which experimenters with more regularly grown plantation crops planted on cleared land do not usually have to contend. It is the purpose of this paper to describe some of these variations and indicate possible means of overcoming them. It seems likely that in the future cocoa will have to be produced in the Gold Coast at lower prices and in competition with other countries; if so, the questions now being asked about the most economic means of growing it can only be answered by more precise field experiments than have been possible in the past.

Causes of variability

The 'Square Mile' at the West African Cocoa Research Institute, on which it seems likely that many future experiments will have to be conducted, is presumably typical of the surrounding country. It is by no means all suitable for any experiments at all and, even on the more even parts of it, such disturbing factors as rocky outcrops, small streams, differences in soil type and depth, old termite hills, the sites of former villages and areas on which food crops, such as cassava and maize, have been grown, quite apart from irregularly spaced large and small forest trees, are all too frequent.

Forest tree species

Of these variable factors, the forest trees present, perhaps, the most difficult problem. Several of the photographs that illustrate this paper have been obtained in a 10-acre piece of land 'uniformly' planted with Amelonado cocoa, sown by the three-seeds-to-a-stake method, in 1947. On the 'spot plan' made of this area before planting, apart from numerous smaller trees, oil palms etc., some 120 large trees were plotted, of which *Piptadenia africana*, *Triplochitum scleroxylon* and *Terminalia superba* were the most frequent. Any of these trees and several less frequent ones may grow to at least 150 ft. in height and have a girth of 15 ft. above the buttresses; although they are not usually deeply rooted, their root spread may be very wide (Fig. 2). Thus, although a cocoa tree may grow well quite near the trunk, the competition from the feeding roots of the forest tree may be much more severe farther away. The first of the above species is a slow-growing, hard-wooded tree and 10 years after felling the stump, trunk and large branches may have rotted very little (Fig. 3). The other two have softer wood and will rot away more quickly and, if allowed to lie where they fall, the amount of humic material added to the soil must be very considerable, rendering the conduct of, for example, a manurial trial on such land extremely difficult (Fig. 4).

The task of clearing and removing altogether trees of this nature is not only laborious, but very expensive.

Fig. 2. Root spread of fallen tree, Combretodendron africanum

Moreover, the physical effect on the soil, particularly of the removal of the root systems of large trees and clearing of the undergrowth, may be highly deleterious to the establishment and subsequent growth of cocoa; thus, even if it is possible to find a quick-growing cover crop that will not only cover the ground rapidly, but also yield substantial quantities of plant material for building up the humus content of the soil, it may be several years before the land can be considered fit for planting again. It is hardly surprising, therefore, that in many of the older experiments the larger forest trees have been left *in situ* and, even where the land has been ' clear felled ' and regularly spaced shade and cocoa trees have been planted, no attempt has been made to remove the root systems or trunks of the larger trees (Figs. 3 and 4), though sometimes sections have been cut out of the felled trunks to enable a new tree to be planted in the gap (Fig. 4).

Where the larger trees have been left there is another hazard which may add to the variation. If trees die the branches and finally the trunk itself may fall on the mature cocoa trees, breaking the essential canopy and, quite apart from the direct damage, render the trees more liable to attack by insect pests. Furthermore, in the sudden gales that are a feature of the climate of this part of Africa, tall trees may snap off halfway up the trunk or even be completely uprooted, crashing into the cocoa and irremedially damaging the experimental trees below (Fig. 5). The process of thinning out the shade trees by poisoning with arboricides, such as 2:4-dichlorophenoxyacetic acid (2,4-D) or 2:4:5-trichlorophenoxyacetic acid (2,4,5-T), must inevitably lead to damage of this kind, even though the smaller branches may do little harm, and for that reason is not very desirable.

Returning to the other natural causes of heterogeneity, it is obvious that, as with all experiments, eroded patches of soil, rocky outcrops and small streams (Fig. 6) ought to be avoided in the design of an experiment if at all possible. Although their effects may be detrimental, this is not always so. Thus in a trial for the control of capsid one plot was found to be especially badly affected; on examination it proved to contain a steep slope, where the soil was obviously eroded, running down to a small stream. In this area the cocoa had established and grown very poorly and appeared to be highly susceptible to capsid attack. On the other hand, apparent rocky outcrops may be simply piles of boulders with deep pockets of soil among them, in which the cocoa may grow quite well. Again, it is by no means certain that the presence of an old termite hill in a plot will lead to poor growth. On an establishment trial at W.A.C.R.I., one of the heaviest cropping plots to date is largely occupied by a very large, abandoned termite hill. Any one of these factors, whether good or bad, must surely increase variation.

Fig. 3. Buttress roots of Piptadenia africana *10 years after felling. Note that little rotting has occurred*

Scattered throughout the bush there are many sites on which small villages formerly stood. Cleared of forest trees and surrounded by fruit trees, such as mango, avocado pear etc., these have generally reverted to grass. Evidently on such sites and the surrounding areas affected by village waste and leaching from it the nutritional status of the soil, and probably the soil structure also, have been materially upset and it is always difficult to establish cocoa in such places as compared with the surrounding bush. Similarly, there are patches of land that have been used in the past for food crops, such as maize and cassava; these are commonly in a low state of fertility and again it is difficult to establish cocoa in such situations.

Influence of diseases and pests

As with all perennial plants, uncontrolled diseases or pests, unconnected with the purpose of the trial, are a fruitful source of error. It is doubtful, however, whether in this respect cocoa is worse off than several other crops. For example, even in England the experimenter with many varieties of plums must be prepared for the death or crippling of some of his trees by silver leaf or bacterial canker disease, also many fruit plants suffer from virus diseases of varying severity, whose effect can certainly not as yet be eliminated. The swollen shoot disease of cocoa has in the recent past accounted for many thousands of acres of cocoa and, until it could be brought under control, any other experimentation was nearly impossible. Very careful and frequent inspection, coupled with prompt cutting out, have now reduced the losses due to this disease to small numbers. Nevertheless, the experimenter must expect to lose some trees from this disease during the long life of his trial. The ravages of black-pod disease again are responsible for the loss of many pods in high rainfall areas, but at W.A.C.R.I.,

where the rainfall is lower, the effects of the disease are not so severe.

Undoubtedly, in recent years the capsid bug, together with the *Calonectria* disease that follows it, have been much the most serious of the pests and diseases that are a source of error in field experiments. Despite the small populations of the pest usually present in cocoa plantations, its ravages have been widespread and, whenever the growth of the cocoa is weak or the canopy has been broken, owing to one or other of the causes already mentioned (*e.g.* Fig. 5), there has been a tendency for ' capsid pockets ' to form, accentuating the damage and further increasing the variability. Where the cocoa trees were attacked early in their lives and conditions for growth were good many appear to have made a remarkable recovery in growth, though whether or not this applies also to cropping is not so clear; but where conditions are not good and severe infections with *Calonectria* have followed the damage caused by the feeding of the capsid the trees may have been crippled or killed.

Quite recently a method of controlling capsid, by mist-blowing with BHC, seems to have been found, which, if efficiently carried out, should go far to eliminate this very serious source of error and it is hoped that, as with the apple capsid bug, which was formerly such a serious pest in England and which has now virtually disappeared from Kentish orchards, before long it will be no more than an unpleasant memory. If this desirable state of affairs is to come about, though, the methods of control will have to be widely adopted by cocoa farmers and much more attention paid to such matters as the provision and maintenance of spray apparatus and the supervision of spray gangs than seems usual in West Africa today.

It is hardly possible to complete this list of sources of error in cocoa experiments and ignore what may be lumped together as errors due to inefficient recording. It seems undeniable that on occasion an unknown proportion of the crop is lost or not recorded at all. Further, the standard of labour available for the recording of field experiments seems very low and there must be many instances of mistakes being made. Qualified research workers must today certainly rely very much on the recording staff and a much closer supervision by trained men seems essential unless the volume of research is greatly reduced.

Future field experiments

Cultural experiments on Gold Coast cocoa are at present urgently needed. Thus, quite apart from those concerned with diseases and pests, definite answers are required to questions concerning shade, with which are bound up tree nutrition (about which little is known), cover cropping, pruning and other cultural operations; new, more vigorous heavier cropping varieties are now becoming available and their relative merits must be tried, but they can only be used to the best advantage where appropriate distance of planting, pruning, etc., are determined.

It is obvious that, as long as the sources of error already described remain uncontrolled, it will be difficult to give precise answers to such questions. Nevertheless, it may still be several years before it is possible to do experiments with less variation and methods of making the best use of existing conditions must be considered. Such experiments are of two classes: (*a*) those that must start with the planting of the experimental trees or even earlier; and (*b*) those that need not start until the trees are established. In the first category must be placed variety, spacing, establishment and shading trials, but pruning, manuring and trials involving the culture of mature cocoa need not commence for several years after planting.

Pending the time when large forest trees and their effects can be removed, even though it may be possible to avoid such disturbing factors as rocky outcrops, shallow soil etc., only the simplest experiments in the first category should be attempted. In the design of these two guiding principles must be observed. Firstly, in each experimental plot the treatment appropriate to that plot must be carried out exactly; this is comparatively easy where varieties are to be compared, provided ample nursery plants are available, so that a proper selection of comparable trees for planting can be made. It is not so easy where shaded and unshaded trees are to be compared or in spacing trials where the shade or competition from forest trees is uneven. Secondly, it is essential to observe the two fundamental statistical principles of replication and randomisation. In the face of very large local variations elaborate designs for the estimation and elimination of positional variation and the reduction of real replication by the use of factorial designs with several factors are out of place.

Fig. 4. *Trunk of* Triplochitum scleroxylon *nearly rotted away 10 years after felling. Note section of trunk removed to allow cocoa to be planted in the gap*

Fig. 5. Fallen Combretodendron africanum *showing damage to mature cocoa below*

Factorial arrangement

It will be better to concentrate on a few well-contrasted treatments, making use of a simple factorial arrangement where possible, ensuring by more than adequate plot replication that, if economic differences are shown, their significance will be beyond doubt. Very little is known at present about the optimum size or shape of plots for such experiments and until the methods of experimentation, varieties and planting distances of the cocoa of the future can be more nearly foreseen it seems hardly worth-while to explore these matters further. For the present plots should be made large enough to ensure, firstly, that the treatments they represent are accurately reproduced and, secondly, that their yields are not unduly influenced by the absence of or need to discard a varying proportion of the trees within each plot. Usually the method of randomised blocks, possibly using split plots, where very large plots with extensive guarding are needed to reproduce some of the treatments, will be the most suitable. For example, a comparison between shaded and unshaded trees might be made on large main plots, each of which with guards might occupy as much as an acre and be replicated eight or even 12 times; the main plots might then be split into four for comparisons of two varieties each at two distances of planting. Such experiments must of necessity occupy large areas; nevertheless, if they can give a clear answer to a definite question, they must be much more worth-while than smaller experiments with many treatments carried out under ' bush ' conditions.

The device of ' calibration ' seems the obvious method for use in experiments on the culture or nutrition of established trees. In brief, it entails the planting and recording of individual trees or plots without any treatments until they can be considered established, *i.e.* until at least one and preferably two full crops have been harvested. The experimental treatments may then be applied, the subsequent results being related to the pretreatment records, using the well-known statistical device of the analysis of covariance for the purpose. The success of the method must depend on the choice of the calibration measurement and its correlation with the subsequent performance of the trees; a study of the existing records over a period of years to this end is likely to be well repaid.

If such a useful relationship can be established, the method seems particularly suitable for future field-scale trials of plant nutrition. For the purpose a series of blank, suitably guarded, plots might be planted. If the eventual purpose of the trial can be foreseen, *e.g.* a $2 \times 2 \times 2 \times \ldots$ factorial design, an even number of blocks of eight or 16 plots might be very suitable. If not, one of the highly adaptable designs recommended by Pearce[2] for calibration trials might be useful. Sometimes such series of plots might form the subplots of large main plots, comparing, for example, shaded and unshaded trees, though, until regular planting is possible, such an arrangement might be too complicated.

These blank plots, if the cocoa therein is carefully tended, should be ready for use in from five to eight years, according to variety. In the meantime all possible modern resources for the elucidation of problems of plant nutrition by intensive experimentation can be brought to bear on the problem to discover what elements are likely to be needed by the trees. On the basis of the knowledge thus accumulated appropriate treatments can be chosen for the calibrated plots in the field trial, when they are ready to receive them.

Simplicity

Simplicity is the keynote of the kind of experiment envisaged so far. The conduct of more complex field trials must depend on the provision of areas of land cleared of forest trees and rehabilitated to a state in which cocoa planting is again possible. The felling and clearance of the trunk and roots of the large forest trees already described is in itself a major operation; with it comes the problem of restoring uniformity to the land thus disturbed and growing some form of cover crop to maintain or improve the fertility. Once the land is cleared and fertility restored it should be possible to plant more uniform experiments with both the cocoa and the necessary shade trees regularly spaced. It seems likely that matters such as the spacing of the cocoa and the nature and density of shade trees at various ages in the life of the cocoa will be themselves subjects for experiments, but it seems unlikely that such trials will become possible until the initial problem of ground clearance is firmly tackled and reasonable and practicable means found of overcoming the difficulties.

To sum up, the usual method of growing cocoa in the Gold Coast today permits of only the simplest field experiments, calling for generous replication to provide clear-cut answers to straightforward questions. More elaborate experimentation must await

Fig. 6. Cocoa growing on banks of a small stream. Note the effect of washing of root system

the evolution of methods of clearing and rehabilitating land before planting.

Acknowledgment

The foregoing paper places on record observations made during a 10-week visit to the West African Cocoa Research Institute, Tafo, for the information of those who are unfamiliar with experimental conditions in the Gold Coast. The visit was made at the invitation of the Director, Mr. J. Lamb, to assist him to review and, where necessary, reorganise the programme of field experimentation. The author would like to thank the Director and staff of the Station, who unreservedly placed much information at his disposal, and particularly Mr. R. J. Benstead, who also took the photographs that illustrate this paper.

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The Role of Fertilisers in Rice Production

(*Continued from page* 349)

Superphosphate (300 to 400 kg./ha.) applied before sowing or transplanting is therefore necessary.

(4) *Potash.*—Only one of the experiments mentioned proved the importance of potash in fertilising. It is, however, recommended to apply 100 kg./ha. of potassium chloride before sowing or planting.

N.B.: Fertilising of nurseries.—There is no basis for affirming that the fertilising of nurseries leads to an increase in yield. It should ensure a better 'take' of seedlings after transplanting and a better tillering.

Conclusion

The success of the recent development of rice growing in the Mediterranean Basin makes it possible to envisage its future extension into countries having a similar climate: strong light in spring and summer, the alternation of a moist period (autumn, winter) with a dry period (spring, summer). The irregularity of the precipitation makes necessary the setting up of irrigation systems, and the present cost of labour is forcing the rice grower to use modern cultural techniques: powerful and well-adapted machinery, possibly the aeroplane.

For tropical rice growing, although the maximum yields obtained are definitely lower than those of the Mediterranean zone, the present levels of yields suggest that in the underdeveloped Asian countries (*e.g.* India, Malaya, Indonesia) immense progress is still possible with fertilising. Is it not clear that the figures which have been mentioned are a striking proof that fertilisers are an essential factor in production? The populations who have little means must be instructed in the advantages of organic manuring: leave the rice straw on the ground, do not waste or lose manure, make compost of all possible refuse. At the same time they should abandon certain ancestral practices (of gathering, threshing etc.). The productivity both of their soil and of their labour would be improved and rice growing would become profitable. It would then be possible to pass to the second stage, that of chemical fertilisers, at first extending the use of phospho-nitrogenous basal fertilising, and then of split nitrogen top-dressings, completed possibly by a potash fertilising, especially on marsh soils.

In conclusion, the judicious combination of heavy organic manuring with an application of nitrogen and phosphate fertilisers should considerably raise production in the great Asian rice-growing areas. The fertilising of rice-fields would make it possible to avoid still more frequent famines and to help, in the more or less near future, to improve the standard of life of populations who are often wretchedly poor.

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Photos: p. 347 *FAO*

International

Coffee

The U.S. Department of Agriculture estimates the 1956–57 world coffee production at 46.7 million bags. This is 7% less than the 50.2 million produced during the 1955–56 marketing year. Last year's crop, the Department said, appears to be the largest on record.

Scientists from 42 Countries at Plant Protection Conference

Experts on crop protection from all parts of the world, including some of the foremost international authorities, attended the Second International Plant Protection Conference at Fernhurst Research Station, near Haslemere, Surrey, England, recently. Over a period of three days, as guests of Plant Protection Ltd. (a subsidiary of Imperial Chemical Industries Ltd.), these world-famous research workers discussed crop protection problems, which included the part the geneticist can play in breeding plants immune to attack, the hazards arising from the use of toxic chemicals and the remarkable advances made in the use of systemic insecticides.

The 200 delegates heard diverse views on the means of combating weeds, insect pests and diseases, which together account for the loss of almost a quarter of the world's supplies of food every year.

Although a volume of proceedings will be published by the organisers of the conference, we are fortunate in being able to publish for the benefit of our readers short summaries of most of the papers read during the conference.

World Aspects of Crop Protection

by J. G. Knoll (Head of Plant Production Branch, FAO).

Early efforts in international co-operation date from 1881, when the Phylloxera Convention was signed, and in the same year a plan for international action was mooted at the International Congress for Agriculture and Forestry at Vienna. The matter was further discussed at subsequent international congresses and conferences, and the International Institute of Agriculture at Rome, founded in 1905, had as one of its objectives the better control of plant diseases and pests. International agreements were adopted in 1914 and 1929, when a draft Convention was adopted, to be replaced by a new Convention in 1951.

Special international agreements for locust control date from the draft Convention of 1920, with abortive attempts in 1926, 1929 and 1934. Only in 1938 was an effective international locust-control organisation established.

After the 1939–45 war plant protection received far greater attention, first, as an essential feature in agricultural rehabilitation programmes; second, because of both the better facilities for international co-operation and the increased risks of spread of pests and diseases from country to country, as a result of increased speed and range of modern transportation; and third, because, with the discovery of highly potent synthetic organic crop-protection chemicals, their manufacture and use became a highly competitive industry.

The Food and Agriculture Organisation (FAO) of the U.N., established in 1945, includes plant protection as a major phase of its programme. FAO has encouraged its member governments to form regional plant-protection organisations; such bodies have been formed under its aegis for the European and Mediterranean region, for Central America and Mexico. Other international agencies (*e.g.* the South Pacific Commission, the Commission of Technical Co-operation for Africa South of the Sahara, the International Institute of Agricultural Sciences, and the Commonwealth Agricultural Bureaux) have also engaged in promoting plant-protection programmes, and bilateral agreements have been made between governments for technical assistance in this field.

Although plant quarantine is no protection against the spread of some diseases (*e.g.* those with airborne spores), it can, if effectively enforced, prevent the further spread of some diseases and the spread of other destructive diseases and pests of still limited geographical distribution (such as South American leaf blight and Oidium mildew of rubber; American leaf spot and Hemileia rust of coffee; witches' broom and swollen shoot of cacao; various diseases of sugar - cane, sugar - beet, tobacco, bananas and potatoes; and among insect pests, various pests of cotton, cacao, sugar-cane, sugar-beet, cereals, potatoes). There is also potential danger from the spread of noxious weeds.

With the aid of FAO, work is being done in the control of fall webworm,

A general view of some of the 200 delegates in the conference marquee. An interesting innovation was the use of 60 television sets (on closed circuit) for showing slides during the lectures

Colorado beetle, olive fly, Mediterranean fruit fly, the grain-eating weaver bird, the rhinoceros beetle.

Technical assistance, including the provision of experts to various countries and the training of local students, is being given by FAO under the Expanded Technical Assistance Programme of the U.N., and under bilateral agreements between governments, especially under the U.S. Point Four Programme and the Colombo Plan. Valuable services are also given by the Commonwealth Institutes of Mycology, Entomology and Biological Control; also by private enterprises, notably the Rockefeller Foundation.

The control of pests and diseases cannot be regarded as the sole responsibility of government officials, scientists and interested commercial enterprises and the growers. The ultimate objectives will not be achieved until everyone who consumes plants and plant products understands the problems involved and accepts his or her share of responsibility. A barberry bush hidden in someone's backyard may produce inoculum of stem rust enough to ruin hundreds of acres of cereals.

Genetics in Relation to Crop Protection *by W. F. Hanna (Division of Botany and Plant Pathology, Department of Agriculture, Ottawa).*

Varieties of food crops resistant to diseases and pests can contribute greatly to increasing world food supplies. In Western Canada alone stem rust disease may destroy 100,000 tons of wheat in one season.

Great progress has been made, by breeding and selection, in the production of wheat varieties resistant to rust since the pioneer work of Biffin at Cambridge 50 years ago. Similar work has resulted in the production of resistant varieties of many other crops, examples of which are mentioned, which have made possible great increases in the acreages grown and in yields per acre.

Resistance is a genetic character susceptible to Mendelian laws and to the techniques of breeding and selection based thereon. But economic factors dictate whether it is worth-while to carry out the expensive and lengthy work required to develop new resistant varieties or whether to use chemical control.

The production of varieties resistant to fungus, bacterial or virus diseases plays a much larger part than that of varieties resistant to insect pests; for the control of such pests chemical insecticides are, up to now, the more prevalent means.

But the development of disease-resistant varieties is greatly complicated both by the difficulty of producing varieties resistant to relatively non-specific fungi able to attack a wide range of different crop plants, and even more by the existence of different physiologic races or biotypes of more specific disease fungi. Crop varieties resistant to one such race may be very susceptible to attack by other races of the same fungus.

The time taken for a new virulent race to increase from a trace to epidemic proportions may be from seven to 10 years. The time required to produce a new variety of wheat is about 10 years. International co-operation among rust investigators has contributed greatly to the adoption of measures for expediting breeding programmes in order to narrow the gap between the appearance of rust in quantity and the distribution of a new resistant variety. It is still too soon to say that a complete and lasting solution of the rust problem from the breeding of new varieties can be found.

Mechanisation and the demand for a uniform product has often led to the cultivation of one highly purified variety over large continuous areas. If the variety has a restricted type of resistance, it is likely to fall an easy prey to a new physiological race of the parasite which its restricted type of resistance cannot withstand. By demanding uniformity in food crops and by relying on a single source of resistance Man has worsted disaster.

The only practicable alternative at present in sight is chemical control, but a fungicide that is not too expensive and will retain its toxic properties over a period of two weeks or more during which the wheat crop is exposed to infection has still to be found. From the cost viewpoint a systemic fungicide would seem to be the most useful. The application of a rust-control fungicide as a spray should not present much difficulty, having regard to the extent to which herbicide spraying is now used. In 1955 over 14 million acres of grain crops in Western Canada were sprayed with herbicides.

The Physiology of Immunity of Some Agricultural Plants *by K. T. Sukhorukov (Main Botanical Gardens, U.S.S.R. Academy of Sciences).*

The author, writing as a plant physiologist, discusses how a study of the differences in the physiology of resistant and susceptible plants, and of the disturbances caused by disease in the physiology of plants, can greatly advance our knowledge not only of the physiological processes of the undiseased plant, but, even more, can give valuable guidance to plant breeders, phytopathologists and crop-protection specialists.

In studying the physiology of immunity attention must thus be directed to the physiological peculiarities of immune plants and of the disease organisms, to the inter-relations between host plant and parasite, and to the physiological means of defence by the plant, and of attack by the parasite, all with due regard to the influence of environmental factors.

The author describes work by himself and his collaborators in this field on certain important and widespread diseases, namely cotton wilt, cereal rusts, mildew of cereals and roses, rots caused by botrytis, sclerotinia and fusarium, potato blight and wart disease of potatoes.

Blackarm Disease of Cotton and its Control *by R. L. Knight (East Malling Research Station, England).*

Blackarm is a bacterial disease which causes damage wherever cotton is grown, except in irrigated or flooded areas which have no rain at or just after sowing. It may attack leaves, stems or bolls and on susceptible varieties, if not controlled, it may reach epidemic proportions and cause crop failure. In 1930–31 it caused the yield in the Sudan Gezira to fall from the average of 400 lb. to 130 lb. of lint per acre. Subsequently it was brought under control by seed dusting and plant hygiene.

The author started genetical research on blackarm resistance 20 years ago with the objects of making the Sudan irrigated Sakel and the rain-grown American Upland cotton crops resistant to blackarm by breeding varieties containing resistant genes. Over 1,000 different varieties and species of cotton were tested; types showing

high resistance were crossed with susceptible Sudan cottons and the genetic nature of their resistance was investigated. Ten major resistance genes were found in this way and nine of them were transferred to Sudan Sakel. These genes were derived from cottons which had become resistant by natural selection through introgressive hybridisation in West Africa and India while growing for 100 to 200 years under conditions ideal for epidemic blackarm attack.

It has been demonstrated that efficient control of blackarm can now readily be obtained by plant breeders by using some of the resistant genes already discovered. Varieties resistant in the Sudan have been bred which yield from 50 to 150% more than otherwise comparable susceptible varieties and much of the cotton now grown in the Sudan consists of these new resistant varieties.

The discovery of a new resistance-intensifying gene has made possible the breeding of cottons resistant or even *immune* to blackarm, even under conditions of very heavy rainfall, when the leaves may be wet or even waterlogged for long periods, and when some of the new varieties which are resistant under drier conditions become susceptible.

It seems likely that by using a simple combination of certain of the genes discovered by the author blackarm can now be controlled in any area of the world.

Many of the delegates toured the Plant Protection Ltd. research farm at Fernhurst during the three-day conference

Mechanisms of Toxicity with Special Reference to Fungicides *by S. E. A. McCallan (Boyce Thompson Institute, Yonkers, N.Y.).*

At the present time we have, for most pesticides, no adequate and final explanation as to how the chemical reacts with the organism so that it inhibits or kills. Most attention has been given to the relation between chemical constitution and biological responses, a knowledge of which is essential to an intelligent screening programme in the search for better pesticides. At least 100,000 chemicals among those evaluated for fungicidal activity alone are of known chemical structure.

The goal in developing many pesticides is now that of selective toxicity. For fungicides to be applied to plants selective toxicity is put to its severest test, for we are trying to kill or inhibit one plant (the fungus) which is on or in another plant.

It is probable that most selective toxicants operate either by inactivating one or more enzyme systems or by changing the permeability of cell membranes or some other physical property of the cell essential to its normal growth and development. Studies on the effect of fungicides on enzyme systems are rather recent, but significant progress will result from this approach.

The paper then reviews published results of research on fungicidal action, and hypotheses based thereon, considering various classes in turn, *viz.: elemental sulphur*, *organic sulphur compounds* (metallic dithiocarbamates, *e.g.* ferbam and ziram; thiuram sulphides, *e.g.* TMTD or thiram; and *bis*dithiocarbamates, *e.g.* nabam, zineb and maneb), *copper and mercury compounds*, *phenols*, *quinones* (*e.g.* chloranil and dichlone), *heterocyclic nitrogen compounds* (*e.g.* glyodin), *8-quinolinols* (oxines and their chelated metallic compounds), and indicates those cases in which acceptable hypotheses have been advanced for their mode of action.

The rest of the paper is devoted mainly to studies in the author's laboratory on the uptake of fungicides by fungal spores, using radioactive tracers, and discusses their bearing on dosage response curves and specificity.

Some Physicochemical and Physiological Problems Associated with the Mechanisms of Toxicity of Insecticides *by J. W. L. Beament (A.R.C. Unit of Insect Physiology, Cambridge, England).*

Most laboratory studies on insecticides attempt to relate either mode of application, or of cuticle penetration or transport to a 'site of action' to toxicity. But the actual cause of death —and in a population, of its demise— may vary greatly even when one specific insecticide is similarly applied to closely related animals. The paper calls attention to the need for recording the physiological cause of death in insecticidal experiments and suggests that variation between different species *after* an insecticide has reached its 'site of action' should be considered as an equally important facet of interpreting insecticidal action.

Some of the very recent work on cuticle structure and physiology is reviewed in relation to insecticidal transmission: while we need more information on the structure of sense organs and similar specialised areas of cuticle, there are now suggestions that the living material has a more extensive control of the cuticle than may have been thought—that an influence may extend to the very outermost layers of epicuticle, and that physiological differences within the individual cuticle

may be at least of the same order of importance as structural differentiation in specialised areas.

An attempt has been made to reconcile the somewhat contradictory information in the literature on the mode of action of inert dusts and carriers; this indicates that the very complex picture which may one day emerge to explain the process of toxicity may not, in fact, follow a continuous and ' linear ' sequence of events, but that there may be very considerable ' secondary ' actions. These will only become obvious—and their importance realised—when we study the physiology of events after the toxic material has reached its ' site of action ' and the physiology of death.

The Mechanism of Toxicity of Insecticides and Fungicides *by J. T. Martin (Long Ashton Research Station, Bristol, England).*

As in the case of fungicides (see paper by McCallan), there is good evidence that insecticides also exert their toxic action by inhibiting enzymes which are essential in cellular metabolism. This has been shown by work on the organophosphorus insecticides on carbamic acid esters, and on DNC, and it is probable that this also applies to thiocyanates, phenothiazine, DDT and aldrin. Evidence regarding gamma-BHC is conflicting and nothing is yet known regarding the action of nicotine, rotenone or pyrethrin on specific enzyme systems.

For fungicides, the fact that some disease fungi are controlled by sulphur fungicides and others by copper fungicides also seems to be related to differences in the action of these two types of fungicide on the key enzyme systems of the different fungi.

Further work in this field may serve to develop more rational, rapid and economical methods of selecting toxicants than the present kind of screening trials.

The greater part of the paper deals with work at Long Ashton on the relation of toxicity to the manner in which the toxicant is brought into contact with the pest or disease organism (usually by spraying) and the bearing of the results on the development of improved spraying machinery. This involves studies of the nature of spray deposits—the factors affecting their amount and distribution, the degree of coverage, their physical characteristics and behaviour, and the relation of variations in these factors to the degree of control of the disease organisms. New and elegant experimental methods have been developed for these investigations.

Spraying with a large volume of wash does not necessarily give complete coverage; much depends on the physical properties of the plant surface and on the formulation of the spray. The concentration of toxicant in the spray is no indication of the amount retained on the plant. More formulation for particular purposes is most desirable. We must extend our conception of dosage from pounds of chemical applied per acre to include a measure of availability and potency of the toxicant at the site of action. We are using many of our crop-protection chemicals at needlessly high rates. At Long Ashton, by using a low-volume air-directed mist, control of aphides on apple trees was obtained by deposits of DDT only one-tenth as large as those given by large-volume spraying. Such reduction in rates also reduces mammalian and phytotoxicity hazards. Moreover, the way is opened for the development and use of expensive chemicals with greater specificity in effect, which are ruled out at present on economic grounds.

The Role of Systemic Insecticides in World Agriculture *by Robert L. Metcalf (Department of Entomology, University of California Citrus Experiment Station, Riverside).*

Systemic insecticides are insect poisons which can be absorbed by plants (*e.g.* through roots or foliage) and permeate their tissues in the sap (or accumulate in parts of the plant susceptible to insect attack), thus poisoning insects which feed on them.

The properties needed for a systemic insecticide are defined as: sufficient solubility in water; ability to penetrate into the plant through root, leaves or stem; sufficient stability to persist in the plant for a reasonable time.

The current position of systemic materials for crop protection in agriculture is then reviewed, with special reference to the well-established commercial compounds, *schradan*, *dimefox*, *systox* (*R*) or *demeton*, *metasystox* (*R*), and to other promising materials now under large-scale testing or in limited commercial use, *e.g. OS-2046*, *pyrazoxon*, *mipafox* or *isopestox* (*R*), *R6199*, *Thimet* (*R*), *isolan*. The use of these materials is discussed from the standpoint of crops, pests, dosage, application methods and timing.

One of the most promising uses of systemic insecticides is as seed dressings for the protection of young seedlings, *e.g.* cotton, sugar-beet, lucerne, cabbage. This is likely to make possible the relatively inexpensive insurance of a healthy plant stand without several of the early treatments otherwise required and it seems safe to predict that such use will ultimately be made on millions of acres.

Another potentially very important development is the use of systemic insecticides with selective action in such a way that, while controlling noxious insects, they do not kill off the natural parasites and predators of such insects or other beneficial insects liable to suffer from ordinary contact insecticides.

Systemic insecticides also show great promise in the prevention of virus diseases which are propagated by insect vectors.

Public health problems of the use of systemic insecticides are then considered, in relation to hazards to the consumer of food crops which have been so treated, and with special reference to available information on the toxicity of such compounds or their transformation products to human beings, and the rate of decomposition or metabolic transformation in the plant tissues of such materials.

Systemic Fungicides and Bactericides *by P. W. Brian (Akers Research Laboratories, The Frythe, Welwyn, England).*

Systemic treatment of fungal and bacterial diseases is still in its infancy and there have not yet been revolutionary developments similar to those with systemic insecticides, nor is it yet possible to predict whether such developments are likely to occur.

Some antibiotics have been used successfully as systemics for the control of bacterial diseases of plants, but the range of choice is limited by the danger of phytotoxicity. Promising results have been obtained with both streptomycin and griseofulvin, applied to the roots, but with the former root

absorption takes place readily with some kinds of plant, but with difficulty or not at all by others. Moreover, it has not been proved that the use of streptomycin as a systemic results in better control of a bacterial disease than its application as a spray to the leaves. It may be effective in both cases simply because it is a good bactericide.

Good control of rust diseases has been obtained with the synthetic sulphonamides, but these, too, are also phytotoxic, so that there is still the problem of finding an effective dose which does not damage the plant.

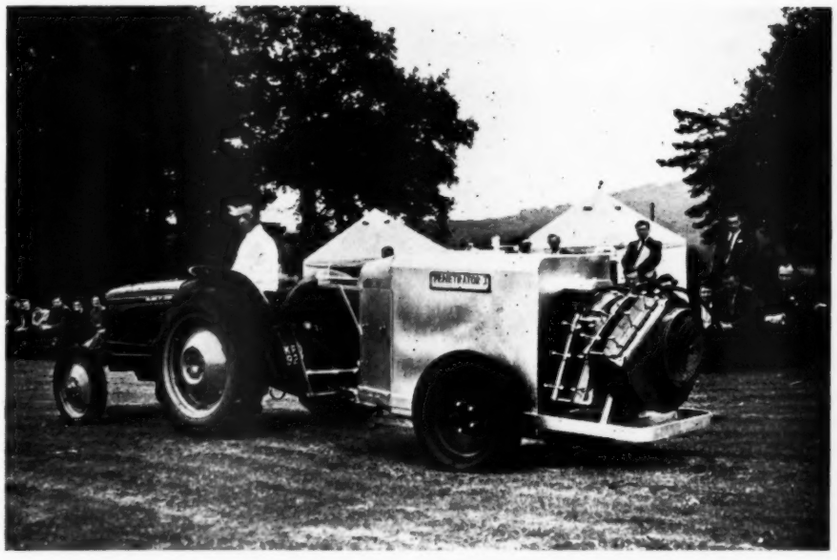
Another problem in the use of systemics which does not arise with toxicants applied externally is that of their susceptibility to metabolic changes in the plant. These must not be so rapid as to give little persistence, but they must not be so slow that there is danger of harmful residual amounts in food crops.

The absorption of systemic fungicides through the leaves of plants has not been much studied, but cases of their downward translocation from leaf to root have been reported. This suggests the possibility of their use in this way to control serious root diseases if a sufficiently selective systemic can be found which, while being highly toxic to the root disease organism, does not impair the activity of the native soil saprophytes in the vicinity of the root, which also play an important part in checking the activity of the root disease organisms.

Chemical Weed Control in Sweden; Some Results and Viewpoints *by E. Aberg (Institute for Plant Culture, Uppsala, Sweden).*

Recent changes in cropping systems in Swedish agriculture, by the inclusion of a greater proportion of crops requiring less labour (cereals) and a tendency to eliminate bare fallows, have much increased the importance of weed control in growing crops. Mechanical cultivation is now used mostly in row-seeded crops and there is much scope for selective weedkillers for cereals, flax etc.

Much work has been done on the effect of selective weedkillers on the crop plants. Experiments with cereals, linseed, flax and potatoes indicate that MCPA is less likely than 2,4-D to produce abnormalities in growth or reduction in yield, and that in both cases harmful effects can be avoided if the herbicide is applied in the right way.



At the termination of the conference many plant-protection machinery manufacturers showed their latest machines. Here the 'Penetrator-3' is going through its paces

Continued use of only one herbicide may tend to modify the weed population in the direction of more resistant species; MCPA, while remaining the predominant weedkiller in Sweden, is likely to be used more in association with other products, notably 2,4-D and/or DNOC. Experiments are also in progress with DNBP and chlorinated phenoxbutyric acids.

Different kinds of sprays and spraying machinery for use with selective weedkillers have also been studied. MCPA was found to be as effective in low-volume as in high-volume spraying on spring-sown cereals and linseed.

The use of IPC against wild oats is also being studied. Its effect is dependent on soil-moisture content and rainfall. The best control is obtained on germinating wild oats at seeding time in spring.

TCA and dalapon are both being tried against couch grass. They are best used in spring on land to be bare fallowed, and seem to be about equally effective.

Hazards Arising from the Use of Toxic Chemicals in Agriculture *by J. M. Barnes (Toxicology Research Unit, Serum Research Institute, Woodmansterne Road, Carshalton, Surrey, England).*

This paper deals only with the hazards facing people who handle toxic chemicals. Such chemicals have been used in agriculture for many years and there is nothing novel about the control of their use by statutory regulations and legislation.

A new era in the use of synthetic insecticides began with the introduction of DDT and BHC on a big scale in 1945. Both proved so safe to handle that few precautions have ever been taken by those using them on the largest scale. Soon afterwards, with the introduction of the organophosphorus compounds, there were a few cases of poisoning by parathion and there had already been some serious cases of poisoning by DNOC used as a weedkiller.

The hazards arising from the use of other toxic materials, such as the new chlorinated hydrocarbons (aldrin, dieldrin, endrin, chlordane), pentachlorophenol and mercurial fungicides, are also discussed and analysed.

For outdoor workers the skin is the main route of exposure, whereas indoor spraying also involves risks from inhalation. Experience suggests that even the most dangerous chemicals can be used with only minimum precautions, *e.g.* prevention of contact with the skin (as by wearing a shirt) and, above all, by thorough washing with soap and water, but that these minimum precautions, and especially the availability and the use of facilities for washing, are absolutely vital.

In many cases poisoning has been

the result of gross carelessness by workers or ignorance of the risks involved through lack of proper instruction. Rules and regulations must be designed to protect the careless worker.

Treatment for cases of poisoning by the common crop-protection chemicals are outlined, including atropine in cases of poisoning by organophosphorus chemicals and barbiturates for poisoning by chlorinated hydrocarbons.

The Problem of Residues from Pesticides in Foodstuffs from the Point of View of Health *by R. Fabre* (*Professeur de Toxicologie à la Faculté de Pharmacie de Paris, Membre de l'Institut*) *and R. Truhaut* (*Professeur, Faculté de Pharmacie de Paris*).

This paper is in three parts, dealing respectively with toxicity in general and in its various aspects, with the ways in which possible risks to the consumer may arise and with means of obviating such risks.

In the general considerations on toxicity the various factors affecting the actual toxicity to man of inherently toxic substances are discussed.

Substances which are not specially dangerous in single, relatively large doses (acute toxicity) may be much more dangerous in small oft-repeated doses (chronic toxicity), whereas for other substances the reverse may hold. The risks of carcinogenic toxicity are emphasised.

Possible risks to the consumer from the application of crop-protection chemicals to food crops are considered in relation to the kinds of crops usually so treated, and especially those treated very near the time of harvesting. Fumigants are less likely intrinsically to leave persistent residues, but even they, and still more solid or liquid pesticides applied in sprays or dusts, may leave persistent residues, sometimes not readily susceptible to removal by cleaning treatments (*e.g.* washing or wiping), especially with substances which are fat or oil soluble and may penetrate into the plant and be retained in the lipoid constituents. This risk is most likely with crops containing much fat or oil (*e.g.* olives, citrus fruits). The risks of noxious residues are inherently greatest when systemic insecticides are used.

Many examples are given to illustrate these problems in the case of insecticides. Examples are also given of the risks of harmful residues in products derived from crops, *e.g.* wines, fruit products (juices, tinned fruit, jam), edible oils, milk and butter, flour.

Indirect effects of residues are also considered, such as reaction with some food constituents and consequent impairment of nutritive value or promotion of digestive disturbances.

Reference is also made to the possibility of objectionable flavours or taints from the use of some pesticides.

The prevention of these risks to the consumer involves, in extreme cases, prohibition of the use of certain substances and, in less extreme cases, the fixing by law of maximum tolerance limits to the permissible amounts of residues.

A complementary method of obviating these risks is the prohibition of the application of certain crop-protection chemicals in the later stages of growth of the crop. French regulations in this regard for various crops are cited.

Of the many problems still demanding much attention, perhaps the most important is that of educating the growers of food crops: in the nature of the crop-protection chemicals they use, the reasons for restrictions in their use, the nature of the risks involved, and how to use them so as to combine good control of pests and diseases without risk to the consumer.

The Residual Effects of Crop-protection Chemicals in the Soil *by F. J. D. Thomas* (*Head of the Merrindale Biological Research Station, Croydon, Victoria, Australia*).

Pesticides applied to the soil may have harmful effects on crop plants either directly, by affecting germination or growth or by tainting or poisoning the crop, or indirectly, by interfering with beneficial soil organisms. Such effects are dependent on rate of application, level of toxic concentration in the soil and rate at which the chemical is lost from the soil by decomposition or otherwise. These points are illustrated by experimental results and experience with BHC and DDT.

With herbicides it seems that most modern weedkillers break down fairly quickly in the soil, but a possible residue hazard exists with pentachlorophenol (PCP) if used at high rates.

The immediate effects of some insecticides on soil bacteria are considerable, but there is no evidence of any serious permanent changes in bacterial populations being caused. Such changes are unlikely except with very high residual insecticide concentrates.

Some herbicides (*e.g.* 2,4-D, 2,4,5-T) have little or no effect on the activity of soil micro-organisms, whilst others (*e.g.* TCA, PCP and IPC) cause significant reduction in activity, but these effects are very temporary, except perhaps with PCP and IPC at high rates.

There is no evidence of harmful effects of BHC and DDT on beneficial soil fauna (*e.g.* earthworms), although sometimes parasite/predator relationships may be changed.

The Mechanics of Producing Sprays of Different Characteristics *by R. P. Fraser* (*High-speed Fluid Kinetics Laboratory, Department of Chemical Engineering, Imperial College of Science, London*).

This paper deals with the dispersion of small liquid particles through the atmosphere in the process of spraying for crop protection and with the problems of high-speed fluid kinetics and associated engineering problems which are involved. Spraying problems are complex owing to the many variables concerned; variables within the atomiser, variation in liquid properties and variability of atmospheric and field conditions.

New requirements are met with in connection with low-volume spraying, arising from the need to minimise water transport, especially in arid areas, and from the fact that for some modern crop-protection chemicals (*e.g.* selective herbicides) only a few drops are needed per leaf or per plant.

Atomisation by pressure is discussed, using swirl spray nozzles producing conical sheets, or fan-spray and impact nozzles producing flat sheets. The use of rotary atomisers of various kinds employing centrifugal force is then considered, after which twin-fluid atomisers using air at low, medium and high pressures are discussed.

The mechanism of disintegration of liquid sheets, for the study of which high-speed photography is needed, is then described, with the disintegration of the sheet into liquid filaments, which

then break up into separate drops, large or small according to specified conditions. The mechanics of flow in the sheet and the various modes of disintegration for different kinds of sheet are discussed and the factors influencing the stability of liquid sheets are specified.

Methods of measuring drop size—direct and indirect—are described and an account is given of the results given by these methods in the study of the effects of atomiser design and liquid properties on drop size and the disintegration of drops travelling through the air, together with a discussion of drop-size requirements to obtain sufficient toxicity with liquid insecticides under various conditions.

Mist-blowing and Mist-blowers *by E. W. B. van den Muijzenberg (Director of the Institute of Horticultural Engineering, Wageningen Research Station, Holland).*

The control of plant diseases has to be done with the smallest quantity of poison. Also it is essential that this quantity is dispersed into particles, which have to be applied to the plant as uniformly and with as little energy as possible. The action of the ordinary motor sprayer, speed sprayer, the hand-driven and the automatic mist-blower are compared in this respect. By using the mist-blower a large saving of time and material can be obtained, and in this way the protection of plants can be secured at the correct time and with less cost than by using the motor and speed sprayers.

Methods of Insecticide Application Against the Desert Locust *by R. C. Rainey (Senior Entomologist, Desert Locust Survey, East Africa High Commission).*

Operations against the desert locust, in 64 territories from Morocco to India and from Iran to Tanganyika, are costing over £5 million a year. In Morocco alone, in 1954, crop damage assessed at £4½ million was inflicted by locusts.

Poison baiting using a stomach insecticide, such as gamma-BHC or aldrin, is the most widely used method, which may be very effective under favourable conditions. A kill as high as 34 kg. of hoppers per gramme of gamma-BHC has been recorded, but the method is very expensive (*e.g.* 20 times as high as that of aircraft spraying per unit of insecticide used) and unreliable, especially against older hoppers.

Dusting may sometimes be very effective against adult locusts, especially if they are wet with rain or dew, but under more typical drier conditions kills may be negligible.

Spraying from the ground by large machines is usually not mobile enough to deal with swarms on the move, which may travel 500 miles. There are, however, great possibilities for cheap and simple low-volume spraying machines used in large numbers and one such machine is mentioned.

Aircraft spraying is used against both settled and flying swarms. For settled locusts application of a concentrated insecticide at ½–1 gal. per acre can be used. Swarms, even when settled, are readily located from the air. The kill depends on the density of the swarm: 220,000 per gal. for a roosting swarm of 70 per sq. yd. was obtained in Kenya in 1955, and for a thin swarm of 10 per sq. yd. the kill was 48,000 per gal.

Against flying locusts the rate of application must be about the same as for settled locusts, but using a fine spray and emitting it within the swarm itself a higher kill is obtained in a flying than in a settled swarm. Here, too, the density of the swarm, which may range from less than one per 100 sq. yd. to over 10 per sq. yd., is the most important single factor. In trials in the Sudan in 1954 kills in a thin and in a dense swarm were 16,000 and 52,000 per gal. respectively.

Apparently the kill depends on both the rate (amount) and the speed of application. In Northern Tanganyika a flying swarm of about 2 sq. miles was completely destroyed by 600 gal. of DNC spray in one day, the kill being 350,000 locusts per gal. The kill depends on the cumulative effect of small doses in successive spray-runs, but such small doses are less effective if not given in rapid succession (*e.g.* all in one day instead of in four successive daily doses). Kills by gamma-BHC are slower than by DNC, but more effectively cumulative: 11% gamma-BHC sprays at 20–250 gal. per sq. mile have given kills of 100,000 to 300,000 per gal.

The best results so far have been obtained by spraying when a dense swarm is partly settled and partly low-flying: kills of 380,000 per gal. with DNC in the Sudan and 700,000 and 740,000 per gal. with gamma-BHC in Kenya have been recorded.

Effective improvements in desert locust control require further understanding of locust behaviour as well as further improvements in insecticides and equipment.

Australian Rice Plan

The Australian Government has made a 30-year agreement to hand over between 500,000 and 750,000 acres for the development of rice growing in the Northern Territory to Territory Rice Ltd., formed recently by Australian and American interests. The company will spend nearly £A5 million to launch the project.

The Minister for Territories, Mr. P. M. C. Hasluck, said that, if successful, the enterprise would change the face of the Northern Territory and would for the first time test on a large scale the agricultural possibilities of the Territory. Already very successful rice-growing experiments have been made in the area.

The new company's properties will extend over sub-coastal plains from East Darwin to the Arnhem Land border.

The Northern Territory Legislative Council has ratified the agreement, which is described by the Director of Lands there as ' the boldest experiment of large-scale land settlement in the history of the Territory '.

He pointed out that there was not a penny of Government money in the project, which could mean a new industry worth millions of pounds and which might support 20,000 people in the not-too-distant future. Under the agreement the company must take up half a million acres of the area within 15 years.

The area over which the option has been taken is at present almost uninhabited and the company will have exclusive rights to the land under 30-year leases. It will invest substantial capital in a pilot area of 5,000 acres and there is an obligation on it to subdivide at least half its leases into farms and transfer them to settlers within 10 years.

Machinery, Co-operatives and Land Limitation in Yugoslavia

READERS of WORLD CROPS will recall from earlier articles on Yugoslavia the main features of the first draft of the new 10-year plan (1953) which is now ready for final adoption. Various issues were opened with that draft.

On the one hand, a bitter discussion started then about the so-called agricultural fetishism that had its origin in the large number of tractors envisaged by agricultural planners. Yugoslav economists insisted that in a country with a large agricultural overpopulation, cheap labour, few possibilities of increased employment outside the scope of agriculture, with primitive tools and backward cultivation methods in a considerable part of the country, it would be pure luxury and, indeed, waste to invest in heavy labour-saving agricultural mechanisation coupled with possible losses owing to lack of proper management and the continual foreign exchange expenses for fuel and spare parts. It has been maintained that the scarce capital accumulation and foreign exchange might be better used for increasing labour investments in commerce. Agricultural technologists, however, when pointing to the great lack of draft animals, which, on the one side, causes high exploitation on the part of farmers possessing animals and, on the other hand, leaves some portion of land uncultivated, stressed the great advantage of tractors for better timing of work and for deeper ploughing as protection against frequent drought.

Smallholdings

The other problem is the long-term perspective of the present overwhelming number of individual agriculturists with holdings below 10 ha., which is the upper limit since the mass withdrawal from work co-operatives in 1953. Will these smallholdings be able to compete in productivity with the average larger-size holdings in technically more advanced countries, which are decisive in establishing the average world price? Will they be able and willing to substitute the shortcomings of a smallholding by any type of co-operativism? What effect will this have in the future when the present generation of children grow up? Will holdings be divided and become even smaller, or will the children find occupation elsewhere outside the sphere of agriculture? This possibility has until now been neglected. Some foreign economists forecast the need for increasing the land limit, for technical reasons, beyond 10 ha.; others believe that Government policy might in the near future turn to the amalgamation of land in peasant work co-operatives and thus express their apprehension that even now, after the re-establishment of friendly relations with the U.S.S.R., peasants might lose their confidence in the stability of individual holdings and lose interest in either short- or long-term measures for more intensive culture. Meanwhile, the recent turn of events represents a new solution beyond the framework of the old systems. It takes into account that the majority of peasants, at present, are deeply attached to individual land property, but, at the same time, the belief is reiterated that smallholdings cannot be profitable, that machinery on small individual strips of land does not pay; furthermore, it is also believed that the manufacture of large-scale machinery has the effect of lowering the high barrier between agriculture and industry. In this way it exerts an urbanising influence. What action should be taken in these conflicting circumstances?

Administrative measures

At the conference of the Union of Co-operatives in April 1956 the Vice-Premier, Edvard Kardelj, agreed with the need for larger investment in agriculture, but not, however, in the private section for two main reasons: (*a*) such investments might be less profitable and represent a rather expensive burden for the national economy, resulting in luxurious personal consumption on the part of a small number of richer people, thus preventing further investment in agriculture; (*b*) they may, in addition, strengthen the private capitalistic tendencies and lead to exploitation in the rural section, thus provoking administrative intervention for the protection of the weaker element and perhaps leading to further restrictions. However, administrative measures are considered undesirable and harmful for the political situation and economic progress.

When admitting mechanisation for the Socialist section only, Mr. Kardelj

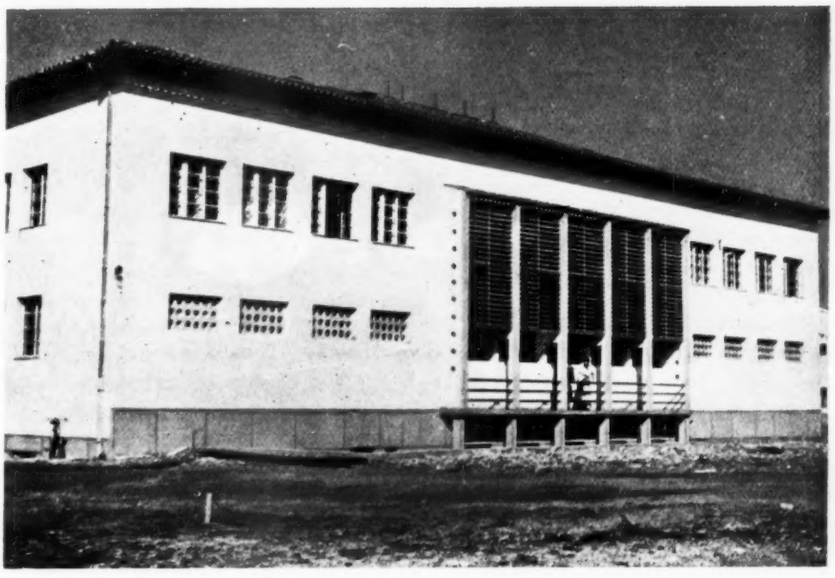
Raspberries are being grown on a co-operative plantation in Komenda, Slovenia

does, however, leave the question of co-operative land ownership for the indefinite future. Such property is not considered by him to be the main prerogative of Socialism in agriculture. The strength of Socialism in agriculture may not be in collectively owned land, but in the existence of collectively owned machinery, breeding cattle, processing plants, irrigation implements etc., no matter in what particular social or legal form (special co-operative unions for the possession of machinery, general co-operatives, or enterprises administered by work collectives by individual farmers); land might still remain in the hands of the individual farmer for an indefinite period, perhaps even as long as required by the farmer. Moreover, any pressure for land collectivisation may cause, under the Yugoslav conditions, unnecessary harmful economic and political consequences, but with more collective machinery, food processing plants etc. being established the land itself takes on less importance. The proportion of the farmer's individual income from pure land rent might be smaller in comparison with what is called in the West income from capital profit and wages. This may slowly produce a change in the psychology of the farmer. An analysis of the existing peasant work co-operatives shows that their large proportion of collectively owned machinery and implements, ensuring a larger proportion of income from labour than from land rent, is the main factor keeping them together.

Subsidies

As opposed to the immediate post-war period, it is essential that mechanisation and other investments no longer be subsidised either in an open or concealed way; the machinery, though acquired with the assistance of Government credit, is to be repaid on commercial terms. Therefore, the introduction of non-paying machinery, dogmatic support of large-scale enterprise when it is not profitable, the general use of tractors and draft animals on the same property, all these things can no longer be repeated. In this way the arguments of the economists can be overcome. There cannot be any doubt that this new policy takes into account practical experience not only from Yugoslavia, but also from smaller countries of the Scandinavian type and Holland, where Socialism achieved much progress among small-holders with their co-operatives under Socialist governments. Also recent theoretical considerations clearly brought forth the fact that Marxism itself does not call for amalgamation of land in all circumstances and periods. Therefore the new attitude in Yugoslavia is not considered a deviation from Marxism or Socialism.

STANE KRASOVEC



A general view of the new dairy factory which was built recently in Sezana, Slovenia

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Reducing Evaporation

Experiments by Australia's Commonwealth Scientific and Industrial Research Organisation in the use of cetyl alcohol to reduce evaporation from water storages on farms have been extended to the U.S.A.

In a recent statement the Minister in charge of C.S.I.R.O., Mr. R. G. Casey, said that Mr. W. W. Mansfield, who had been responsible for the Australian research, was now in Texas, U.S.A., outlining the results of large-scale tests in Australia. These tests, in four States, carried out with the co-operation of several water authorities on dams and reservoirs, confirmed earlier small-scale tests in showing that evaporation may be reduced by from 20 to 70%, depending on conditions.

In the more arid regions of Australia, where water supplies are inadequate and often unreliable, evaporation losses of up to 8 ft. of water occur annually.

Mr. Casey explained that Mr. Mansfield's process maintains a thin invisible film of cetyl alcohol on the surface of the water. This restricts transfer of water to the air, but does not prevent oxygen being dissolved from the air to keep the water fresh. Where normal evaporation is 8 ft. a year, a saving of 45% means a saving of 1 million gal. of water for every acre of reservoir surface.

The Minister stressed, however, that the method was still in the experimental stage and much work remained to be done before it could become sufficiently 'foolproof' to be applied generally.

Hungarian-grown Bananas

Bananas are once again on sale in Budapest, capital of Hungary. When the first bunch since before the war was placed in a fruit shop window in the March 15 Square it caused a lot of excitement.

A rare delicacy in Hungary, the bananas now being sold are home-grown and come from hot-houses on the Fertöd Experimental Farm in north-west Hungary.

The first consignment of 44 lb. sold in a few hours, despite their high price. Small regular consignments are now being delivered to the capital.

Study Group on the Toxic Hazards of Pesticides to Man

From the four points of the compass, at the invitation of the World Health Organisation (WHO) of the United Nations, some of the most distinguished scientists in the world came together from 6–13 June, at Geneva, to consult with one another on the toxic hazards of pesticides to man. Each of these scientists is an outstanding world authority on his particular subject and the purpose of this first meeting was to compare notes on one of the most important questions in pest control today throughout the world.

It is general knowledge that man is waging a ceaseless warfare against the natural enemies which threaten to destroy him, the foods upon which he subsists, his domestic animals and the forage which gives them sustenance. The more intensified is the research into methods of combating these enemies the more extended and complicated does the whole campaign become. In some sectors it is comparatively simple, as where an enemy agent can be isolated and cut off and where there exists a simple and wholly effective method for its destruction. In other cases control and suppression may entail the co-operation of a whole series of different scientific bodies. The ramifications of this research are exceedingly difficult to delimit, overlapping is almost unavoidable and unless prevented may result in quite different and confusing conclusions being arrived at by bodies working independently of, and without reference to, one another.

Classification

The very classification of these enemies has its complexities, as, for example, in the term ' pests '. What can be described as pests and grouped together under this category, for purposes of research into methods of destroying them, due consideration being given to the type of scientific knowledge required for evolving control measures? Insects, molluscs, animals, birds, weeds, bacteria, moulds and viruses are all pests of one or other of the animal or vegetable products which are essential to man or contribute to his well-being, but the evolution of scientific methods of control and their practical application without danger to man himself, or to other forms of life which are valuable to him, involves the interplay of a whole set of different factors which must all be adjusted in proper relationship to one another before a satisfactory solution can be attained.

To add to and further complicate many of these problems there are other factors which must be remembered. Thus a specific chemical or method of application may be employed with comparative safety and simplicity in one part of the world yet be quite impracticable in another. Differences in the standards and regulations existing between the governments of one country and another (or, as is also very often the case, their entire absence) can have a very marked influence on the safe application of control measures. The scientist, working in his laboratory, may produce an apparently perfect remedial measure for a particularly noxious pest, only to find that it is, to all intents and purposes, useless in practice for one of many reasons, such as the impossibility of finding a method of applying it in the field, that its use may endanger or destroy livestock, contaminate food, impart an unpleasant odour or damage the colour of a valuable commodity or be dangerous to the operator. Again, with all the apparent factors taken care of, it may be found that utilisation is effectively impossible because of an unconsidered trifle. For example, a sprayer or dust distributor which is apparently ideal for use by one operator for combating blister blight in tea plantations may be found quite impracticable in application because its weight, which would be considered quite moderate by a workman in a temperate zone, is found to be far beyond the physical strength of the plantation worker, subsisting on a low-protein diet in a tropical zone. Again, a pesticide which can be used with perfect safety by an operator wearing protective clothing and a gas-mask in temperate conditions might have to be abandoned in a tropical zone where it would be ideal, were it not that the operator could not work in protective clothing and gas-mask in conditions of high temperature and humidity.

Complex problems

The extraordinary complexity of these problems may best be indicated by the type of scientist (and his specialised subject) represented at this first Study Group. There was one of the leading toxicologists in the world from Great Britain, a world authority on anti-malaria campaigns from Ceylon, the chief of the Toxicology Section of the Communicable Diseases Centre from Savannah, Georgia, and the chief of the Technology Branch of the Communicable Diseases Centre from Atlanta, Georgia; the chief of the Occupational Health Division from Ottawa, the chief veterinarian and the chief entomologist from FAO, the chief of the Occupational Safety and Health Division of the International Labour Organisation, the Director of Public Health from Mysore, the professor of the Faculty of Pharmacy for the University of Paris, and Switzerland's renowned Dairy Science and Bacteriological Institute at Bern was also represented by its director.

All of these scientists give their services without remuneration to further this essential work. It would, perhaps, not be out of place to stress the fact that, although the grants made for the administration of both WHO and FAO may appear to the uninformed to be ample, they are, in fact, infinitesimal in comparison with the world's needs for these purposes. Thus in each category of activity panels of experts have been organised in each of the contributory nations which compose the membership of the United Nations Organisations. These specialists are all eminent scientists in their own countries and hence can only meet together infrequently. Each, in addition to his own professional activities, carries out research on certain agreed working plans which have been evolved as a result of similar study groups to that which is now meeting, working papers are prepared in advance by each of the scientists taking part and these are discussed in all their aspects at the study groups. As a result a concensus of expert opinion is gathered

together, working committees are formed during the course of the study group to amplify these provisional conclusions or recommendations and finally a draft report is submitted to the Director-General of WHO, who may adopt it according to the priority of the particular problem in relation to its importance for the public weal and the availability of funds and facilities for the execution of any recommended course of action.

In addition, as a result of the conclusions arrived at by the working committees within the study group while it is in session, further working plans and programmes are drawn up for the respective expert committees to work upon during the ensuing period until the next study group is convened.

An indication of the vast field covered in this way (and of the amount of work entailed on the component members) may be gathered from the fact that 27 working papers have been prepared for this initial study group, covering such diversified and lengthy subjects as: ' Methods used in the application of insecticides, rodenticides, herbicides and molluscacides in public health programmes '; ' The control of malaria in regions where the vector has become resistant to . . . insecticides '; ' The role and value of organo-phosphorus insecticides in the control of arthropods '; ' International labelling conventions '; ' Clinical signs in pesticide poisoning and the value of laboratory diagnostic tests '; ' Systems in operation for the control of pesticide levels in food '. The extension and dissemination of knowledge internationally on these subjects will provide an invaluable contribution in man's battles against his most relentless enemies.

NORMAN MACDONALD

Improved USDA-34, a Better Sweet Corn (Maize) for the Tropics

In 1934, after 14 years of breeding and selection work, the Federal Experiment Station in Puerto Rico (U.S. Department of Agriculture) made available to the farmers of tropical regions a sweet maize variety designated USDA-34. This variety still remains the outstanding sweet maize for the tropics, where it has been widely distributed. Varieties of sweet maize commonly grown in temperate areas have often been tried in the tropics, but they are not adapted to the uniform and shorter day lengths of these regions and, therefore, do not develop normally. In addition, temperate-zone types usually are more susceptible to disease, particularly *Helminthosporium turcicum* and yellow stripe mosaic.

Early efforts to produce a tropical sweet maize at this station were concerned mainly with the incorporation of the ' sugary ' factor from temperate-region maize into tropical field types. In 1922 Dr. Thomas Bregger discovered several ears of field maize which contained a number of sugary kernels in a field near Lajas, Puerto Rico. It was not known whether the strain was the result of chance pollination from some sweet variety or whether it was a mutation of the local field maize. When Dr. Bregger left the station two years later the maize-breeding work was turned over to Dr. R. L. Davis, who tested and found the strain from Lajas to be superior to the selections from crosses involving temperate-region sweet maize. Backcrossing, selfing and reselecting for productivity and other desirable characteristics resulted in a tall, vigorous, tropical sweet maize variety that was released as USDA-34.

Fig. 1. Ears of sweet maize variety Improved USDA-34. Note extension of husk which provides protection against insect damage. Ear at right, without husk, is 19 cm. in length

Since its introduction thousands of pounds of USDA-34 sweet maize have been shipped from this station and it has been grown in practically every tropical area in the world. This variety has performed well in Florida and Louisiana and favourably in Arkansas, North Carolina, and as far north as Ohio. Although USDA-34 has been the only variety of tropical sweet maize to gain general acceptance, it was deficient in a number of respects, principally in quality.

Intensive crossing, selfing and selecting from over 300 different strains of USDA-34 have resulted in a substantially improved type that is being released as Improved USDA-34. This sweet variety produces two or more mature ears per plant and is ready about nine days earlier than the standard USDA-34. The sugary kernels, which fill the ear to the tips, are now yellow and they have a tender pericarp. The husk not only closes together about the full length of the ear, but also extends above the ear around the silk, providing better protection against insects (see Fig. 1). The breaking tendency of the culm, common in the standard USDA-34, has been eliminated and the general vigour of the plants improved. Improved USDA-34 compares favourably with temperate-region sweet maize in productiveness and quality.

E. CABANILLAS and J. L. SPENCER,
Federal Experiment Station, Agricultural Research Service, U.S. Department of Agriculture, Mayaguez, Puerto Rico, U.S.A.

Land Grant to University

The offer of a grant of land of approximately 1,000 acres or more on the northern boundary of the Archie Henderson Research Station, near Mazoe, for use by the proposed Faculty of Agriculture in the University College of Rhodesia and Nyasaland has been approved by the Federal Government. This was announced by the Secretary for Agriculture, Mr. J. R. Corry.

Cyprus Anticipates Record Harvest

Cyprus this year expects a record wheat crop of probably well over 70,000 tons—at least 25% greater than last year's crop—and a record barley crop, the best for 50 years.

Although the responsibility for this good news rests largely with the good climatic conditions of last winter and spring, credit must go, too, to the Departments of Agriculture and Water Development for their continuous efforts to improve agricultural conditions in Cyprus. For years the Department of Agriculture has been trying to improve both the quality and quantity of the cereal crops and has greatly encouraged Cypriot farmers to adopt improved methods of cultivation, fertilisation, weed and pest control, and especially to employ, where conditions allow, modern mechanised farm machinery.

Climatic and other local difficulties have, since ancient times, made crop-raising in Cyprus a hard struggle. Limited rainfall, long periods of drought, insufficient irrigation water, many weeds, plant diseases and insect pests and, until recent years, the general employment of sowing and harvesting techniques in use 2,000 years ago have all militated against good agricultural production.

High wheat prices

Today Cyprus farmers are almost the highest paid in the world for their wheat and the Grain Commission, which will buy some 35,000 tons of this year's crop, expects to pay them between £1¾ million and £2 million.

Over the past few years, and thanks to carefully planned campaigns among the farmers, the Department of Agriculture has achieved much in the field of weed control and in the use of insecticides and fertilisers.

Improved seed

Ten years ago the Department began research with local strains of wheat and barley to see whether or not by crossing them with seeds from cereal varieties from Australia, Kenya, South Africa, the U.S.A. and Mediterranean countries a species of cereal could be produced with strong qualities of resistance to the many local diseases which beset Cyprus cereals. Improved seed has annually been distributed to farmers and there is no doubt that Cyprus cereal strains have improved through the years. In 1953 the Department began a scheme for the certification of crops, and for their bulking and distribution, under which it undertook to supply farmers with selected foundation seed grown under Department supervision on Government farms. The annual amount of such seed distributed by the Department has been steadily increasing.

Cyprus farmers have, since the war, been making increasing use of mechanised farming implements. Against 27 tractors existing in the island in 1938, and 80 at the end of the war, there are now 1,633 tractors on the island, mostly products of the United Kingdom, and most of them employed in cereal-growing areas. The combine harvester is steadily coming to the fore in Cyprus and there are now 180 such machines in use there.

'Choicest Ceylon'

The Tea Bureau, London, recently held a Press première of an up-to-date documentary film on tea. The film is entitled 'Choicest Ceylon' and it shows scenes that have never previously been shown on the screen. In particular, the famous tea auctions at Plantation House, Mincing Lane, London, are shown for the first time and there are unique scenes of an estate workers' festival, which gave an insight into the background of the people who work on the Ceylon plantations. The complete cycle from seed to packet was depicted. The film is in colour and prints for showing, both 35 mm. and 16 mm., can be obtained on loan direct from the Tea Bureau, 22 Regent Street, London, S.W.1.

Forestry Seminar in U.S.S.R.

A forestry seminar and training centre will be held under the auspices of FAO from 20 August to 30 September at Moscow, Leningrad and the Ukraine, the Crimea and the Uzbek Soviet Socialist Republic. Facilities will be made available by the U.S.S.R. Government as part of the assistance which Russia is contributing to the Technical Assistance Programme of the United Nations.

The seminar and tour will deal with the role of forests and shelter belts in the protection and use of the soil in semi-arid and arid zones. Participants will study forestry-management problems in connection with soil protection and utilisation in these zones, the methods used and the results achieved in the U.S.S.R.

Invitations have been sent to all FAO member countries eligible for technical assistance and that have forestry and soil-protection problems technically similar to those covered by the seminar and study tour.

Steps Against Mediterranean Fruit Fly

A Mexican decree covering absolute quarantine with regard to all kinds of fruit with soft pericarp and any type of market-garden produce was published recently. The decree concerns the Mediterranean fruit fly (*Ceratitis capitata*) and covers the following countries: The Azores, Canary Islands, Portugal, Spain, France, Italy, Hungary, Greece, Malta, Cyprus, Turkey, Syria, Palestine, the whole of the African continent and its islands, Australia, Tasmania, New Zealand, Brazil, Argentina, Bermuda, Hawaii Islands, Costa Rica and the State of Florida in the U.S.A.

Research on Tobacco

Equipment worth over Rs. 500,000 is to be added to the Central Tobacco Research Institute at Rajahmundry (India) for fundamental research work to help improve the quality of tobacco produced in the country.

Disclosing this in an interview, the Secretary of the Indian Central Tobacco Committee said that about Rs. 2.2 million had been set apart for the development of tobacco in the second Five-Year Plan.

The total area under tobacco in the country is estimated at 840,000 acres, producing over 500 million lb. every year, of which, on an average, 90 million lb. is exported. It earned last year a foreign exchange worth Rs. 110 million, besides contributing over Rs. 300 million to the national exchequer.

NEW PUBLICATIONS

Nigerian Cocoa Farmers

An Economic Survey of Yoruba Cocoa-farming Families. By R. Galletti, K. D. S. Baldwin and I. O. Dina. Published on behalf of the Nigeria Cocoa Marketing Board. Pp. xxii + 744, inc. 60 appendix tables. 5 maps bound in. Oxford: Clarendon Press. London: Cumberlege. 1956. 105s.

This book, of immense size and scope, and containing a multitude of tables and five explanatory maps, can only be described as tremendous. It is a report which embodies the results of a survey of the cocoa-producing areas in Nigeria, the report being sponsored by the Nigeria Cocoa Marketing Board. The authors have done more than justice to their task, for in this magnificent tome are recorded the results of a four-year survey of how the cocoa farmers in the Abeokuta, Ijebu, Ibadan, Oyo and Ondo provinces live, work and secure their livelihood. The Board set certain terms of reference and required the survey to include a record of the cost of establishing and maintaining the cocoa farmer's holding, the extent of the farmer's indebtedness to middlemen of various descriptions, and the other occupations by which he and his family add to their income. Various economic factors, such as the effect of co-operative societies, facilities for borrowing money, employment by the farmer of paid labour, the cocoa-marketing processes, and the effect on his economic well-being of the present system of marketing, were also required to be investigated. Then, too, the authors studied the effect on the farmer of such environmental factors as water supplies, communications, primary marketing, cost of imported goods etc.

The Board also required the authors to record the effect of cocoa farming on the production of food crops in the cocoa areas and the effect on the economic production of cocoa of the existing system of land tenure.

All these points and many more have been illuminated during the course of this comprehensive and valuable report.

'Nigerian Cocoa Farmers' has been divided into three broad divisions; the first gives a general account of the economic and social organisation of the areas and of the resources and pattern of living of the cocoa-farming communities. The second part is devoted to an analysis of the economic life of 187 families, based on records kept continuously for all working members of the families over a whole year. The economics of cocoa and food farming are elucidated and the authors report in detail on the variation of production, consumption, trade, and income according to seasons, locality and size of family are examined in detail. Finally, the present system of marketing and the economic potential are discussed.

The Nigeria Cocoa Marketing Board, the three authors and the publishers are to be congratulated for publishing this magnificent work. The published work, the final result of the experience, research and labour of this team, is a volume that will undoubtedly be a welcome addition to the literature studied by economists, sociologists, anthropologists, administrators and by all who profess a desire to learn more about peasant societies and the progress of under-developed countries.

E.L.B.

The Culture and Marketing of Tea

By C. R. Harler. 2nd edition. Pp. xi + 263. Oxford University Press; London: Cumberlege. 1956. 25s.

Many changes have taken place in almost every aspect of the tea industry since the first edition of this book was published in 1933. Considering the importance of these changes, the author and publisher are to be congratulated on having decided to revise entirely the matter contained in the first edition, thus bringing the present volume up to date. In his preface the author states that the war and its aftermath have considerably changed the business aspect of supply and demand. Yet such changes may be regarded as superficial compared with those brought about by the findings of scientists studying tea in the various countries of production and in London. These developments are clearly outlined by the author with commendable accuracy.

Naturally a book of this type cannot expect to explore and solve all the problems connected with tea culture, manufacture and marketing, but, nevertheless, the author has managed to incorporate a great deal of information that will be of advantage to planters, scientists, merchants and the general tea-drinking public.

The book is divided broadly into three parts. Part I deals with the tea plant, production, chemistry and pharmacology. The second part is devoted to the history, development and cultural practices in the main tea-growing areas of the world. Some space, too, is given to the possibilities (and even progress) in growing tea in Australia etc.

The final part is an exposé of the tea trade in general, the four chapters making up the major part of this section being entitled 'The Development of the Tea Industry', 'Tea Tasting', 'The Marketing of Tea' and 'The Production, Export and Consumption of Tea'.

In the final chapter the author draws some remarkable general conclusions with regard to the culture and marketing of tea. He stresses that the Assam Valley is the country *par excellence* for tea planting and that the methods now advocated and followed by the best Assam tea estates are fundamentally sound and should be tried out in other tea countries, with modifications where necessary. As a counter against the complications that may arise from the continued use of artificial fertilisers, he advocates tea-growing under leguminous shade. Among other conclusions Mr. Harler stresses that orthodoxy is required in making ordinary tea and he goes on to mention mechanisation, the best type of organisation for tea estates, etc.

This is a book well worth the reading and it should find a place on the desk of all those interested in tea, whether it be as seed or in the cup.

H. TRAVERS-BROOKE

Advances in Genetics

Vol. VIII. Ed. by M. Demerec. Pp. ix + 402, illustrated. New York: Academic Press Inc.; London: Academic Books Ltd. 1956. $9.00.

The eighth volume of this review series, which is intended primarily for specialists, maintains the high standard set by its predecessors, with a further assortment of papers on inheritance in both plants and animals. The eight contributions in the current volume include one on 'The Complementary Genic Systems in Flax and Flax Rust', by H. H. Flor, who is well known

among crop breeders for his research at the North Dakota Agricultural Experiment Station on this important disease of fibre flax and linseed. A remarkably close genetical relationship has evolved between the flax plant and rust fungus (*Melampsora lini*): for each gene determining the reaction of the host there exists a specific gene-conditioning virulence or avirulence in the parasite. Dr. Flor describes how it is possible to breed varieties having a wide range of resistance to old and new races of the fungus.

Horticulturists equipped with some general knowledge of genetics will find 'Cytogenetics of the Tomato' by C. M. Rick, of the University of California, and L. Butler, of Toronto University, an interesting survey. Much research has been done in recent years on the cytology and genetics of this crop, particularly in the U.S.A. and Canada, and anyone wishing to keep abreast of the latest discoveries likely to have repercussions on tomato breeding should turn to this useful review, in which the inheritance of several economic characters is discussed.

The remaining papers on plants are chiefly of theoretical interest and deal with fundamental aspects of evolution: 'Metabolism and Spontaneous Mutations in Plants' by F. D'Amato and O. Hoffmann - Ostenhof; 'The Genetic Structure of Races and Species of *Gilia*' and 'Chromosome Repatterning and Adaptation', both by V. Grant.

A. L. Rae, of the Massey Agricultural College, University of New Zealand, gives a comprehensive account of the genetics of the sheep. Beekeepers will be interested in a contribution on the genetics of the honey bee and other types of bee by W. E. Kerr and H. H. Laidlaw, Jnr.

Those attracted by the neat designs embellishing the forewings of ladybird beetles may be persuaded to add scientific knowledge to their admiration by a paper on these patterns by the Japanese geneticist, T. Komai.

THERESA ASHTON

FAO Publications

Functions of a World Food Reserve: Scope and Limitations.—The possible functions of an internationally owned and operated World Food Reserve are discussed in a comprehensive report just released by FAO. The report discusses the scope and limitation of using current agricultural surpluses for the relief of chronic food deficiencies and famines or preventing excessive fluctuations in prices of agricultural products and presents an account of the international consultations and actions so far undertaken in this field. The report was prepared at the request of the United Nations' General Assembly and was discussed by the Economic and Social Council of the UN at its session in Geneva in July. U.S. $1.00 or 5*s.* 0*d.*

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Report of the Second Technical Meeting on Co-operatives in the Caribbean.—In January 1951, at Port of Spain, Trinidad, a Technical Meeting on Co-operatives in the Caribbean, which was organised jointly by the Food and Agriculture Organisation of the United Nations and the Caribbean Commission, recommended, *inter alia*, the holding of such meetings periodically.

The objectives of the second Technical Meeting on Co-operatives in the Caribbean, briefly stated, were to facilitate an exchange of information and to pool the experience of co-operative workers by constituting a body of authoritative opinion suitable for the guidance of future co-operative development in the Caribbean. At the same time the meeting could draw attention to matters requiring further investigation, and it could also formulate recommendations as to the ways in which technical assistance can best be afforded on an exchange basis within the region or from outside the Caribbean by international agencies.

*

Peaceful Uses of Atomic Energy

We have received a copy of 'Peaceful Uses of Atomic Energy—Vol. 12, Radioactive Isotopes and Ionizing Radiations in Agriculture, Physiology and Biochemistry'. This volume concerns the applications of radioisotopes in the life science of agriculture, physiology and biochemistry. The agricultural section includes studies on crop genetics, soils, fertilisers, the food uptake in plants and the promotion of useful genetic mutations. This volume is one of a series of 16 which record the proceedings of the international conference in Geneva, August 1955. U.S. $9.00, 63*s.* 0*d.* sterling, 39.00 Sw. fr.

*

Aerial Survey Publication

Under the title 'Ninety-two Million More Mouths to Feed', Hunting Technical Services Ltd. have published an illustrated booklet concerning the comprehensive aerial and mapping surveys undertaken by them for agricultural purposes. It is very well prepared and deals with land use reconnaissance, soil classification, range surveys, forestry and geological and geophysical surveys. A short description of the techniques used is included.

*

Experimental Husbandry

The first findings from the Ministry of Agriculture's own experimental farms were published recently after eight years of research and study. The Ministry, which in 1948 began to buy a chain of farms in England, now has a dozen, ranging from a 2,000-acre estate in Cardiganshire to one of 109 acres near Boston in Lincolnshire. The results of research work from these experimental centres will be published from time to time in the new journal, *Experimental Husbandry*, the first issue of which has articles summarising experiments on manuring of light soils for wheat and potatoes. Published by H.M.S.O. 3*s.* 0*d.*

*

American Potato Yearbook

This publication consists largely of a statistical review of potato production in U.S.A. and Canada. Much information is provided that is of benefit to North American growers. A short onion supplement is also included. Published by C. S. MacFarland, New Jersey, U.S.A. U.S. $2.00.

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Fire Protection Bulletin

This bulletin, supplied free on application to the Fire Protection Association, 15 Queen Street, London, E.C.4, includes a tabulated survey of the supposed causes of fires during 1954. From this table readers can see where essential precautions should be taken and the bulletin contains a summary of what these should be.

MACHINERY AND EQUIPMENT

Pick-up Hitch

The new Fordson automatic pick-up hitch can be fitted quickly to all new-type Fordson Major tractors equipped with hydraulic lift and linkage by a simple rearrangement of the lifting rods and the removal of the top link. Quick-release pins are used in all cases to cut time to a minimum.

In use, the point of pull of the hitch is well forward of the rear axle and, it is claimed, this factor, together with the transferred load from the trailer, increases adhesion considerably. All trailing implements, such as muck spreaders, corn drills, mowers and similar equipment fitted with a 'single'-type hitch on the tow bar, can be coupled to the tractor without the driver leaving his seat.

The driver does not have to ' twist ' unnecessarily to release the hitch locking device which is operated by a foot pedal and has a totally enclosed and spring-loaded mechanism. This protection ensures that the locking device cannot be rendered inoperative by mud and water. The hitch is raised and lowered by ' finger-tip ' hydraulic control. There is a ' stop ' on the hook which enables the operator to locate the implement ' single ' accurately when coupling up. Once coupled and automatically locked, pressure on the hydraulic system is relieved. Implements are prevented from becoming detached over rough ground by the design of the housing.

With the hitch stowed, normal three-point linkage implements can be operated. The p.t.-o. can be used in conjunction with implements on the linkage (*i.e.* F.R. potato spinners and root harvesters) or with the hitch for such implements as power-driven muck spreaders and balers.

If operators should wish to remove the automatic hitch and fit the standard swinging drawbar or vice versa, seven bolts only are involved.

Grain Moisture Tester

The ' Agrometer ' is a stem hygrometer with which the moisture content of grain, seeds, maize, rice, coffee, tea, tobacco, jute, flax etc. can be determined within the shortest time without any preparation and with a high degree of accuracy.

Reader Service

For further information on any item of machinery or equipment reviewed in this section please write to:

Reader Service,
WORLD CROPS,
Stratford House,
Eden Street, London N.W.1,
England

It is directly calibrated to show the moisture content of wheat, barley, oats and rye, but all other granular hygroscopic materials can be measured with the aid of correction charts, which give the result shown on the scale in terms of moisture content percentage.

The instrument has a 30-in.-long, double-wall shaft, the bottom portion of which is perforated and contains a specially prepared bunch of hair sensitive to changes of inter-granular relative humidity. The humidity of the air within and surrounding the material is in equilibrium with the moisture content of the material to be measured and thus, once the relative humidity condition of the air within the material is known, the moisture content of the material too can be noted. The moisture content results can be read off quite easily on the directly calibrated dial.

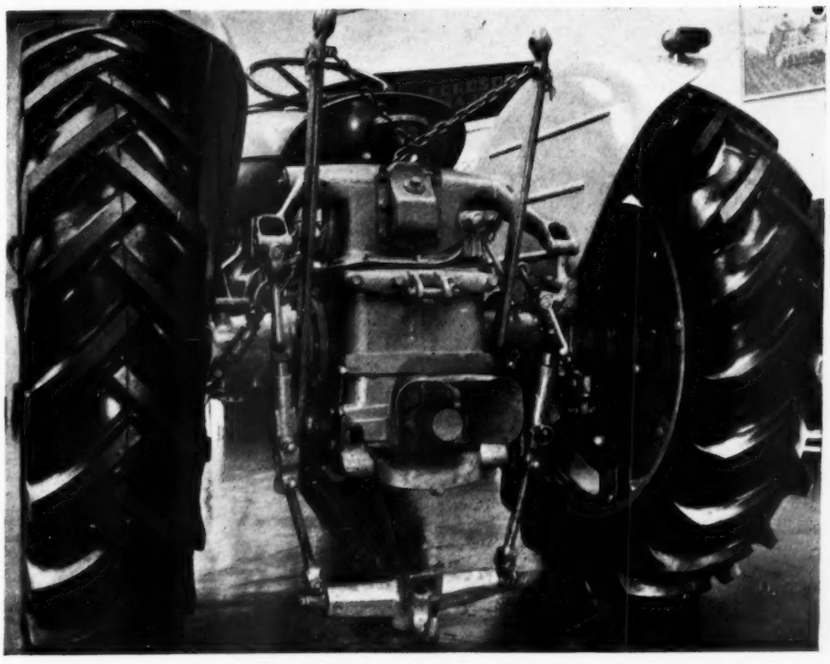
When the instrument is inserted into the grain the sensitive element, which is exposed, reaches equilibrium with the prevailing r.h. conditions inside the mass of grain, which in turn is in equilibrium with the moisture content of the material, and the element takes up moisture from the wet material and the actual moisture content is shown on the dial when the pointer stops moving.

In order to safeguard the element from any material when inserting the instrument into grain, the stem of the ' Agrometer ' is double-walled and the outside tube can be rotated in relation to the dial, thus closing or opening the perforations. The perforations, of course, should be closed on insertion or removal and should be kept open while the stem is inside the material.

The instrument can be easily re-calibrated.

Self-priming Electric Pump

A new pump unit comprising a self-priming pump mounted on the flange of a split-phase motor has been designed to achieve the advantages of robust construction, high efficiency,



Rear view of a Fordson Major diesel, showing automatic pick-up hitch in lowered position

The 'Alcon' self-priming electric pump operates on the water ring principle and provides a continuous non-pulsating flow of liquid

trouble-free running and, at the same time, making the unit available to all classes of users at an attractive low price.

The pump operates on the well-known water ring principle, where the volume enclosed by the blades of the impeller increases towards the suction inlet and decreases towards the discharge opening, which provides a continuous non-pulsating flow of liquid.

The body is made of close-grained cast iron. The working parts of the pump, namely, the impeller and enclosing chamber, are both made of hot brass stampings. These parts are virtually indestructible and as the motor shaft is made of stainless steel no trouble is expected from corrosion or rusting.

In this pump a mechanical face-type seal is fitted, consisting of a 'Hycar' rubber sealing bellows, a carbon running face and a phosphor-bronze counterface.

The pump can be supplied either for $\frac{3}{4}$-in. or 1-in. B.S.P. connections and drain plugs are fitted to give protection from freezing in cold weather.

Standard motor voltages are 200–220, 230–250, 50 cycles, single phase. A 60-cycle unit will be available shortly.

The pump is self-priming to a suction lift of 25 ft. and will generate a total head of 100 ft.

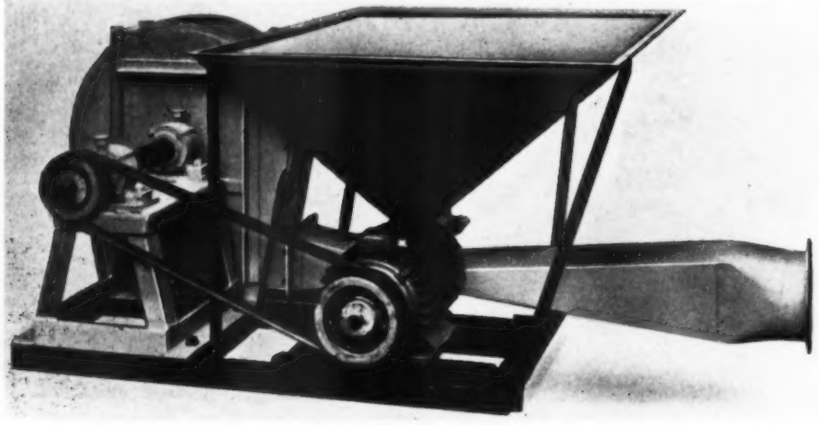
The maximum output from the pump is 500 gal. per hour. Approximate weight: 45 lb. Overall dimensions: length $13\frac{1}{4}$ in., width $6\frac{3}{4}$ in., height $6\frac{3}{4}$ in.

Pneumatic Grain Conveyor

The Byron Mark IV pneumatic grain conveyor is a convenient machine for carrying grain into and out of storage, and moving it from one store to another, in bulk, without handling and without damage. It will handle wheat, oats, rye, barley, maize, peas, beans, rice, coffee etc.

The Mark IV is not limited to straight or horizontal layout; pipes can run round corners and can rise at any angle. There is no vibration and therefore it can be installed in awkward positions and on the rafters of buildings without costly supports. Only one power unit is required, which operates the complete carrying line.

Pipes in 3- and 2-ft. lengths, and selection of various bends, permit build-up of pipe circuit exactly as needed. The pipes have sleeved ends, with 3-in. overlap, making them self-supporting over a considerable span; they are assembled and dismantled without tools.



The latest addition to the Byron line of pneumatic grain conveyors shows increased performance. Throughput up to 7 tons/hour and carry up to 250 ft.

Another advantage is that the conveyor fan can be used for in-bin drying on a small scale.

The machine clears itself completely and leaves no residue in the pipes, thus permitting immediate change over from one type of grain to another without adjustment or cleaning out.

Spout Flow Indicator

The Robinson spout flow indicator, Mk. II, is recommended for use with whole grain and similar free-flowing granular materials. It assists in the control of plant from a central point by indicating exactly when material begins or ceases to flow in any given spout. The indicator is a self-contained unit easily fitted to any shape and diameter of spout, round or square, timber or metal, and it is reliable and maintenance-free.

The Robinson spout flow indicator can be used for whole grain and similar free-flowing granular materials

Construction

The operative unit is housed in a dust-proof, die-cast, aluminium box, $3\frac{3}{4}$ in. × $4\frac{1}{2}$ in. × $2\frac{1}{4}$ in., which is mounted on the spout by means of an aluminium saddle machined on its lower face to suit the type of spouting employed. The detector itself is a sensitively balanced flap valve inside the spout.

The valve is carried on a spindle which revolves on dust-proof bearings inside the saddle. The movement of the valve is transmitted through the spindle to a cam inside the switch box on the end of the saddle. An adjustable, threaded balance-weight arm is mounted into the other end of the spindle.

The movement of the cam actuates a pair of special pivot-arm Burgess

switches. The point at which the switches come in to and out of operation is set by loosening a locking screw and repositioning the cam.

The switches are of a single-pole, double-throw type, linked to a six-way connection box so that both can be wired to make or break contact as required. A $\frac{3}{4}$-in. conduit entry is let into the side of the unit. The unit can be made to light or extinguish indicator or warning lamps, trigger alarm apparatus, or start and stop motors.

Combine Harvester

Below we print some of the construction details of the Ransomes MST42 tractor combine harvester.

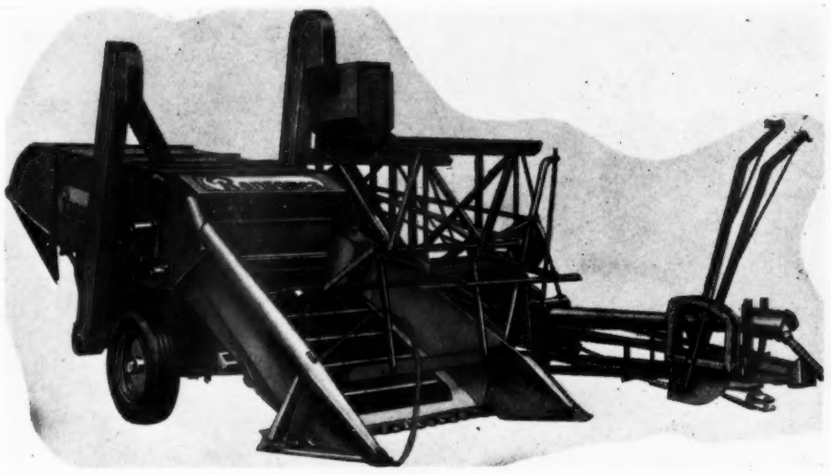
Controls in work.—Two levers operated by the tractor driver allow the only two adjustments which would be normally required in work. One lever serves for the adjustment of the cutter bar for height and is assisted by a double balance spring to eliminate bounce. The other lever controls the reel position in relation to the cutter bar.

Cutter bar.—The knives are of specially hardened steel and, in cutting through two-finger widths, give quick positive action. The knives work to a long stroke, which gives a more efficient cut and eliminates drag. Instead of the knives, a spring-tined pick-up attachment, available as an extra, can be used for windrowed crops.

Frame and wheels.—The strong main frame is made of channel steel and is carried by two wheels running on conical bearings. It is interesting that each wheel can be taken off, complete with the stub axle, after the removal of one bolt.

Bagging platform. — The bagging platform underneath the two-spout grain hopper provides ample room for the operator. A sack discharge chute is slung from the bagging platform. The only operation required to reduce the width of the combine for transport is to unhook this chute.

Concave adjustment.—One touch of the lever on the side of the machine moves the whole concave towards or away from the thrashing drum, allowing rapid adjustment to suit the condition of the crop. For special requirements further adjustment of the concave is obtained by operating the screw adjusters.



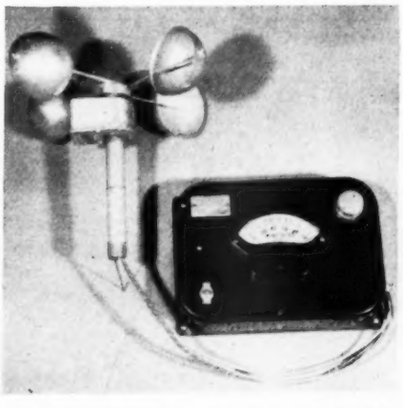
The MST42 combine harvester. V-belt drives are provided throughout and safety clutches protect components liable to damage from overloading

Tailings elevator.—The tailings and loose grain which overrun the sieves are carried by an elevator from the auger below and returned to the shakers, thus ensuring that no grain is wasted. The parts can be interchanged between the two elevators, as they are of the same construction.

Drive. — The well-proven V-belt drive is provided throughout. They transmit the power efficiently and quietly. The inevitable sudden stopping and starting shocks are absorbed in the belts and thus save wear and tear on the machine parts. These belts are easily adjustable and replacements can be slipped on without trouble.

Safety clutches.—The safety clutches protect components liable to damage from overloading. This combine is amply provided with safety clutches which protect the drum, cutter bar, grain elevator, grain auger, tailings elevator and tailings auger.

Adjustments.—All adjustments are very simple and easily accessible. Ample adjustments are provided to keep the combine working at its very highest rate of efficiency. No special knowledge of machinery is required to operate the MST42.



With a scale range of 0–100 m.p.h. this wind speed indicator is operated by a self-contained dry cell

Wind Speed Indicator

Used extensively by American ranchers, forestry departments and metorologists for intermittent readings is the Westach portable wind speed indicator. It has a scale range of 0 to 100 m.p.h. and is operated by a self-contained dry cell, which is replaceable about twice a year. The sender is small, weighing less than 1 lb. and is used either in the hand or on a $\frac{3}{8}$-in.-pipe mast.

Connections are made with three wires (not supplied) from the sender anemometer to binding posts on the side of the indicator case.

Trench Digger

A Cleveland Model 320 trencher recently completed digging some 23 miles of trenches on a 27,000-acre ranch located in the dry bed of Buena Vista Lake in California's San Joaquin Valley. A trench was excavated at the rate of more than 18 earth-bound cu. yd. per minute by a standard Model 320 specially equipped at the Cleveland factory to do this job.

The trenches dug by the Cleveland will be used at times for drainage and at other times for irrigation of the ranch land, as water conditions in the

The Cleveland Model 320 trencher can make trenches 12 ft. wide at ground level, 7½ ft. deep and 52 in. wide at trench bottom

dry lake bed require. This twofold employment of the trenches means that only a minimum amount of the tremendously fertile soil of the lake bed is required for drainage and irrigation canals.

The Cleveland Model 320 trencher can make trenches 12 ft. wide at the ground level, 7½ ft. deep and 52 in. wide at trench bottom.

Digging to accurate grade at a speed of 8 ft. per min., it can throw up spoil banks measuring approximately 5½ to 6 ft. high and 12 to 14 ft. wide at the base. It can discharge spoil simultaneously and evenly to both sides of the big trench.

The trench and the dykes together form water channels 11 ft. deep and 18 to 20 ft. wide at the top.

To excavate the big channels the Cleveland is fitted at the factory with sloper blades, an extra dirt conveyor and an extra conveyor drive transmission. The sloper blades, more than 1 in. thick, are set to cut at an angle of approximately 60° from each side of the 52-in.-wide trench bottom. The trencher's 15 buckets, each 40 in. wide and equipped with extending shanks and rooter tips for cutting the base of the trench, adequately handle the volume of earth cut by the slopers and the digging wheel.

Oil and Water Separator for Air Lines

Bullows and Sons Ltd., Long Street, Walsall, Staffs, England, have recently produced a separator that completely removes oil from air lines at temperatures up to 300° F., and water from lines where condensation has taken place.

Oil normally exists in compressed air in the form of very fine particles and the result is an aerosol (a liquid in stable suspension in air).

The new separator consists of banks of long-fibre felt pads, which have been specially produced for this duty. These pads become wetted by the passage of contaminated air and cause the very fine particles of oil and water to coagulate, which increases the particle size so that the oil and water are easily separated from the air stream.

The filter is self-cleaning and discharges collected oil and water through an automatic valve, so that it will operate for long periods without any attention and without the filtering medium becoming saturated.

It is available for wall mounting in two sizes:

1. The E200 with a capacity of 20 cu. ft./min. at 100 lb./sq. in.
2. The E250 with a capacity of 65 cu. ft./min. at 100 lb./sq. in.

Midget Hydraulic Loader

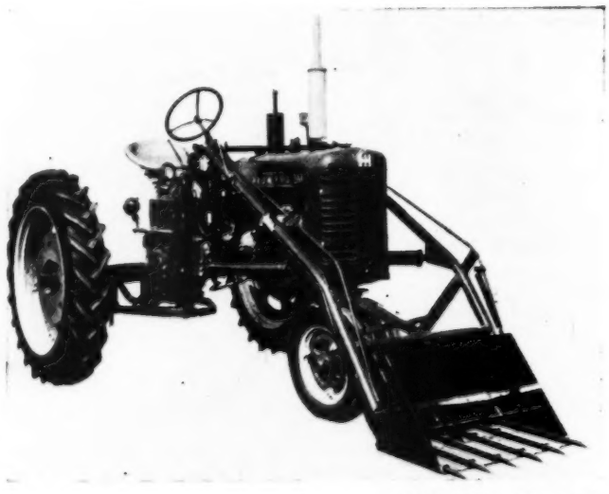
Manufactured to fit a large variety of tractors is the American-built 'Midget' hydraulic loader. It can be attached to, or detached from, the tractor in a matter of minutes; it is easily handled and has no complicated chains, cables, hooks, sprockets or pulleys. The hydraulic cylinders are precision machined.

The implement weighs approximately 500 lb. and is of rugged construction; it is sold complete with combination fork and scoop and Char-Lynn pump. The manure bucket measures 29 in. × 32 in. × 15 in. Other optional attachments are an 18-in. × 60-in. blade and adjustable shoes.

New Battery for Ferguson Tractors

A detachable inspection hatch let into the battery cover is the unusual feature of a new 6-v. Silver Exide unit suitable for Ferguson diesel tractors types TE-F and TE-T. The new battery is assembled in a hard rubber container with integrally moulded handles. Its cover—held firmly in position by the hold-down bolts—incorporates a moulded PVC hatch, which can be removed for easy access to the vent plugs for routine topping up.

Besides the container and cover in hard rubber, the new battery also shares other features of the range.



The American-built 'Midget' hydraulic loader weighs 500 lb. and is solidly constructed throughout

WORLD CROP REPORTS

SYRIA

The April rains continued to be good and the season's wheat and barley crops were estimated unofficially at 1 million and 750,000 metric tons respectively. It was forecast that all cereals would be permitted to be exported freely from June onwards. The export of barley is already permitted.

PAKISTAN

Rice

The third estimate of the area under rice crop, excluding the summer (Boro) rice crop of East Pakistan for the year 1955–56, is 22,870,000 acres—0.1% more than the acreage reported in the corresponding and the final estimates of 1954–55.

The estimated yield of the 1955–56 crop is 7,846,000 tons of clean rice, which is 2.4% less than the corresponding and the final estimates of production of the 1954–55 crop. The decrease in production is attributed to floods in both provinces and insect damage in East Pakistan.

Wheat

The first estimate of the area under wheat crop for the year 1955–56 is 11,577,000 acres, as against 10,583,000 acres reported in the corresponding estimate of last year, and shows an increase of 9.4%.

COSTA RICA

Bananas

Provisional figures indicate that 9,085,790 stems of bananas were exported from Costa Rica during 1955, compared with 10,115,975 stems during 1954. Of the 1955 exports, 7,694,343 stems came from the Compania Bananera de Costa Rico (a subsidiary of the United Fruit Company) and 1,062,651 stems from private growers under contract to the company. Losses during the year due to floods and other causes are estimated at 3,771,959 stems.

Coffee

The 1955–56 coffee crop has proved better than had been originally anticipated, but is, nevertheless, much below that of the previous year. By 31 March export sales had totalled 359,478.34 quintals, for which an average price of U.S. $66.69 per quintal had been paid. Comparative figures for the 1954–55 crop are 478,952.20 quintals and U.S. $65.81 per quintal.

Sugar

The Ministry of Agriculture and Industries announced in February that preparations had been made for the distribution of 3,000 tons of carefully selected sugar-cane shoots of the B-4362 and B-47161 varieties. These shoots are improved types which have been tested and reproduced at the Ministry's experimental farm at Delicias de Puntarenas.

CHINA

China's wheat harvest is expected to be bigger than last year despite heavy flooding in the east central provinces recently, according to Radio Peking.

In a Chinese language broadcast the radio said that other provinces had had particularly good harvests and in all it was expected that 25 million tons of wheat would be gathered.

DENMARK

The area sown to wheat and rye as at 26 May is estimated by the Danish Department of Statistics at 66,000 and 108,000 ha. respectively, compared with 69,000 and 77,000 in July 1955.

The area sown to barley was 644,000 ha., against 611,000 in July last year; that of oats 255,000, against 266,000; and that of mixed cereals 285,000, against 306,000.

U.S.A.

Small grains

Light to mostly moderate showers with some locally heavy amounts on two to four days in the eastern two-thirds of the country interrupted harvesting across the middle portion, but improved the moisture situation in most northern districts, according to the U.S. Department of Commerce Weather Bureau report for the week ended 29 June.

Moisture generally came too late, however, to benefit wheat and oats in the middle and north central Great Plains area and was too light in much of the droughty northern portion of the Western Plains for spring grains.

Harvesting of small grains was virtually completed in the south Atlantic and Gulf states, Arkansas, Texas, Oklahoma and the southern two-thirds of Kansas. It was also well advanced in the northern portion of the latter state and was under way in Nebraska, although interrupted by light to heavy showers.

Missouri wheat was 45% harvested, but yields varied from very low to high, depending on previous moisture conditions. Combining of a very good wheat crop was advancing slowly in the southern two-thirds of Illinois and Indiana, just begun in southern Ohio and under way in Virginia and Maryland.

Maize

East of the Great Plains normal summer heat and mostly adequate moisture favoured the rapid development of maize. In the main belt maize continued to make rapid growth and now ranges in height from 14 in. in Ohio to 48 in. in Illinois. Moderate to heavy rains over most of the Mississippi Valley and the Great Lakes area gave generally ample moisture.

The crop made good to excellent progress in Kansas and Nebraska, but needed rain in most of the remainder of the Great Plains. In central and south central Texas only a light crop was realised. In Oklahoma the crop was fair to good, but declined sharply in the south central portion. In the Dakotas maize was 10 to 25 in. high and well cultivated, but needed rain for development.

FRANCE

Unfavourable weather all spring has further delayed this year's crops, which have never recovered from the severe setback they suffered as a result of the winter's destructive frosts. Under these conditions crop forecasts are becoming quite pessimistic.

In regard to wheat, the February frosts reduced the area under cultivation by about 40%. Resowing obviously could not make up for all the losses and it is generally expected that the end of the season will show a deficit of some 1,850,000 ha. of wheat—

2,700,000 ha., against 4,550,000 last year.

According to the Agricultural Services' estimates of 1 June, the wheat crop this year should be in the neighbourhood of 4,450,000 metric tons. At the same time last year a harvest of 9,383,000 tons was predicted, but in actual fact it amounted to 10,365,000 tons.

On the other hand, the outlook for barley points to a crop of 4,280,000 tons, against an estimate of 2,345,000 tons in June last year, because many farmers sowed barley to replace frozen winter wheat. A slight increase is expected in oats.

JAPAN

Sugar-beet

A 10-year plan has been drawn up to increase the production of sugar-beet in the northern island of Hokkaido, according to the Export Services Branch of the Board of Trade. It is hoped to raise the area at present under cultivation from 39,200 acres to about 132,300 acres by 1965, and an increase in beetroot production from 336,000 tons to about 1,540,000 tons is intended. Working on current rates of domestic consumption and sugar content, this measure will result in something approaching 20% of domestic requirements being met from home sources.

INDIA

Wheat estimate

The All-India final estimate for wheat in 1955–56 puts the current year's area and production at 29,225,000 acres and 8,348,000 tons respectively, according to the Directorate of Economics and Statistics of the Ministry of Food and Agriculture.

The statement says this showed an increase of 1,708,000 acres and 430,000 tons compared with the partially revised figures for 1954–55, which was a peak wheat year. Compared with the average of the preceding five years, however, the figures showed increases of 4,088,000 acres and 1,050,000 tons respectively.

The current year's wheat production equals the target of 8.3 million tons fixed under the Five-Year Plan.

Gram

The All-India second estimate of gram, 1955–56, puts the current year's area and production at 22,206,000 acres and 4,702,000 tons, as against the adjusted second estimate of 20,065,000 acres and 4,535,000 tons, respectively, for 1954–55, showing an increase of 2,141,000 acres or 10.7% in area and 167,000 tons or 3.7% in production over 1954–55. Increase in acreage under gram during the current year has been shared mainly by Punjab, Rajasthan, Bihar, Saurashtra, Madhya Pradesh, Hyderabad and P.E.P.S.U. and, to a lesser extent, by Delhi, Ajmer, Bombay and Himachal Pradesh.

CANADA

With minor exceptions, rains during the last two weeks of June materially improved crop prospects throughout the prairie provinces, according to the Dominion Bureau of Statistics. Warm weather promoted growth, with cereal and special crops making good progress.

Pastures and hay crops were generally excellent in Manitoba, mostly satisfactory in Saskatchewan, but light in many parts of Alberta. Hail and insect damage was minor except in a few local areas.

No rust has been reported so far.

Alfalfa damage

In the 1955–56 season in Canada unusually severe weather was experienced in October and November throughout most of Western Canada. This gave rise to some fears of extensive killing of legume and grass stands. A recent survey has indicated that there is no evidence of more than normal winter damage in any seed-producing area except Alberta and British Columbia. In Eastern Canada, owing to a cold backward spring, growth has been retarded and, although frost occurred unusually late, little damage to legume stands has been noted except in northern and low-lying areas. There was an early and heavy snow covering in Manitoba, followed by a late cold spring and slow growth. There are no reports of winter or spring damage in that area. No winter killing of legume and grass crops is indicated in Saskatchewan.

In Alberta and British Columbia, however, there is evidence of severe damage to some crops. Losses in Alberta may run as high as 65% in stands of alsike and red clover, 25% in alfalfa and 75% of the sweet clover in the area north and east of Edmonton. At the present time there appears to be little damage to the principal grass crops in Alberta, such as creeping red fescue, brome and crested wheatgrass.

Alfalfa stands in the Fraser Valley and interior of British Columbia are considered to be nearly a total loss in many cases due to heaving. Second-year stands of red clover are reported to have been killed and 1955 seedings show losses of 50% or more. In the Peace River district of British Columbia, mostly north of the Peace River, damage to red clover varies from 10% to 75%, otherwise winter killing in that area is generally light.

ENGLAND AND WALES

Agricultural report

Agricultural conditions in England and Wales on 1 July, 1956, have been summarised by the Ministry of Agriculture, Fisheries and Food.

Corn crops are generally satisfactory and are expected to yield about average, except oats, which may be a little below average. Early potatoes are also expected to yield about average. Unsettled weather and slow growth delayed the start of haymaking; estimates of yield per acre of hay are considerably lower than last year. Root crops are not so forward as usual. Livestock are in satisfactory condition.

Weather conditions

The weather during June was generally dull and cool, especially in eastern areas. Rain fell in all parts of the country, but falls were light in some areas. Apart from a few south-western districts, sunshine totals were below average. Temperatures generally were also below average.

Hay

Weather conditions and slow growth delayed the start of haymaking in most parts of the country and in many areas cutting did not start until late in the month. The yields of hay from *temporary grass* and *lucerne* are forecast at 26.4 cwt. and 40.1 cwt. per acre respectively, as compared with yields of 31.2 cwt. and 44.3 cwt. in 1955. The yield of hay from *permanent grass* is expected to be 19 cwt. per acre.